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THE UNIVERSITY OF ALBERTA

AGING IN FEMALE JAPANESE MONKEYS:
PRIMATOLOGICAL CONTRIBUTIONS TO GERONTOLOGY

by

©

MARY S. MCDONALD

A THESIS
SUBMITTED TO THE FACULTY OF GRADUATE STUDIES AND RESEARCH

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE

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DEPARTMENT OF ANTHROPOLOGY

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FALL 1988

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The undersigned certify that they have read, and recommended to the Faculty of Graduate Studies and Research, for acceptance, a thesis entitled AGING IN FEMALE JAPANESE MONKEYS: PRIMATOLOGICAL CONTRIBUTIONS TO GERONTOLOGY submitted by MARY S. MCDONALD in partial fulfillment of the requirements for the degree of DOCTOR OF PHILOSOPHY

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For my parents, Maris and Joseph

for my brothers and sisters, Brenda, Elaine, Gerry, Julia, and Andrea

and especially for David.

ABSTRACT

Interest in the sociology of aging has recently extended to include cross-cultural and cross-species comparative research. In this thesis, current themes in cross-cultural gerontology are presented to provide some context for the discussion of aging across primate species. The present cross-sectional study of the social manifestations of aging in a large sample (N=40) of semi-free ranging Japanese macaque (Macaca fuscata) females was undertaken as a contribution to the primate perspective on gerontology. The reported pattern of reduced social interaction is tested, the existence of a social role for aged females is assessed, and social networks are explored for age-related variation. No evidence is found for social disengagement or for a specific social role for aged females. Some age-related variation in the identity of the members of the animal's social network is found, such as the tendency toward reverse age-homophyly. These network patterns are discussed in terms of the strength of the mother-offspring bond, and demographic circumstances. Overall, it is concluded that old female Japanese monkeys, perhaps primates in general, are not socially distinct from younger adults, and that the assumption of socially or behaviorally distinct old animals may be a reflection of human bias. Menopause, the awareness of mortality, and the division of labor are identified as the three important distinctions between human and nonhuman primates which bear directly on social variation in the later portion of the lifespan. All human societies recognize the aged, or the elderly, as a sub-group in society. The data presented here suggest that nonhuman primates do not have an aged stage in the life course, and that socially, adulthood is essentially continuous to death.

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CHAPTER ONE
INTRODUCTION

RESEARCH AREA

In the past few decades there has been a dramatic increase in interest in human aging, especially in the social and behavioral sciences. Psychology, sociology, and anthropology are among the many disciplines now interested in the later portion of the lifespan. Each contributes a unique perspective on aging as a social scientific issue. Psychology and sociology have provided a wealth of information and new questions regarding the behavior of the aged, as individuals, and as members of a social group. Both deal predominantly with North American or Western societies. Anthropology has extended our knowledge of aging to non-Western and pre-industrial societies. As a sub-discipline of anthropology, primatology is in a position to extend our knowledge of aging one step further – to the nonhuman primates. This investigation will provide a broader primate perspective on aging in the social group.

The primatologist's involvement in the study of aging is important for many reasons, the primary one being the ability (possibly the responsibility) of primatologists to provide gerontology with some cross-species comparisons. A broader primate perspective on aging in social groups may help to highlight and clarify many of the issues which are unique to humans, as well as some which may be part of our primate heritage.

From the perspective of gerontology, the absence of information on aging in nonhuman primates represents a clear gap in the ever-growing body of knowledge about age and human behavior. The behavioral sciences have, for many years, been interested in early life development, and primatologists and psychologists working with monkeys have contributed a great deal of important and insightful material in the area of infant and juvenile development. Since research on humans has now expanded to include adult development and old age, it is important that comparable information on monkeys become available. A broader primate perspective on aging will contribute to our understanding of human aging, as one special case within the more widespread primate pattern.

Primatology also has much to gain from the new interest in aging. Independent of the potential relevance for humans is the fact that primatology lacks specific knowledge of what happens to animals socially as they approach the end of their lifespan. In terms of development, the focus has been on infancy, juvenile development, adolescence, sexual maturity, and early adulthood. The attainment of adulthood is treated as if it were the end product. What happens from there to the end of the lifespan has not been specifically investigated. Undoubtedly, the knowledge and understanding of the later portion of the lifespan which will result from specific treatment will enrich our understanding of other areas and aspects of primate social life.

At the present time, neither primatology nor gerontology can be classified as a mature discipline. Both currently lack widely-shared paradigms which would guide research. Both are attempting to make the transition from description to hypothesis testing and theory building. The small body of research on the behavior of aged monkeys reflects the maturation level of both 'parent' disciplines.

THE STUDY

Concept Clarification

There are many different types of aging. Chronological age is the basic reliable index of the passage of time since birth. Biological aging refers to changes in the level of functioning of the organism. Psychological aging refers to changes in personality and cognitive functioning of the individual. Social aging refers to the observable patterns of behavior of the individual in the group, as the individual moves through the life course. These are not mutually exclusive processes; rather, they are intimately interrelated. Psychological and social aging could be seen as the result of biological aging, although the form that psychological and social aging take will be highly variable across individuals and cultures. Also, the actual relationship between the various types of aging is multidirectional. For example, a change in the social and psychological position of an individual, such as sudden widowhood, may lead to depression and physical frailty, thereby resulting in a change in biological aging. Nonetheless, these different types of aging can be identified, and it is useful to clarify them conceptually. While using the standard index of chronological age as the independent variable, this study focuses upon the manifestations of social age.

All forms of aging and physical health are also intimately related. Separating out the effects of aging from the effects of illness is a problem which has confounded social gerontology. Behavioral researchers have therefore introduced a conceptual distinction between primary (normal, disease free), secondary (disease related), and terminal (pre-death decline) aging (Birren and Cunningham, 1985). For the most part, the sample of old Japanese monkeys used in this study will represent patterns of primary or normal aging. None of the subject females showed any signs of chronic illness or disease. All appeared healthy.

Old *female* Japanese monkeys are the subject of this study. There are a number of reasons for focusing on females. Japanese monkey society is organized by matrifocal kinship bonds, and the life history patterns of males and females are quite different. Females stay in their natal troop throughout their lives, whereas males emigrate. Furthermore, adult males are much fewer in number and have much shorter life expectancies. An age group of males comparable to that of females does not exist. Investigation of the later life of male Japanese monkeys would be a great undertaking in itself, and would require very different methodology and rationale.

In an overview of research design on aging, Nesselroade and Labouvie (1985) emphasized that "description and exploration of a domain are obviously crucial activities and must occur, to some extent, prior to serious attempts to erect a systematic theoretical framework" (1985:37). This study involves both exploration and hypothesis testing. An exploratory investigation of a new and little studied area such as old monkey behavior is a fundamental first step which will lay the groundwork for future research. However, certain accepted hypotheses already exist, implicitly and explicitly, which require testing. This study therefore will undertake clarification of some accepted and some expected patterns of aged behavior.

Methods

The present study is an investigation of the social ramifications of aging in a large, complex, naturally-occurring group of Japanese monkeys, whose exact ages and kinship relations are known. The study site is the South Texas Primate Observatory in Dilley, Texas, which houses an intact, naturally occurring social group of 400 monkeys. The animals are contained in a 58 acre area enclosed by an electrified fence. They are provisioned once a day and also forage on native flora, and they exist with a minimum of human intervention and are habituated to the presence of at least one behavioral researcher. Daily records are kept of births, deaths, injuries, veterinary treatment, and any notable events.

The sample of subjects for the study consisted of all animals in the third trimester of the lifespan (20+ years of age, N=18) and a representative sample of younger adult females (5-19 years of age, N=22), for a total sample of 40 animals. These animals were observed for a total of 15 months, covering all annual seasons, in 1986 and 1987. 440 hours of focal animal data were collected and analysed.

The data were analysed in a variety of ways, using both quantitative description, and statistical testing. Generally, the goal of the analysis was to investigate behavioral differences between animals of different age groups. Pearson product-moment correlations were used to measure the relationship between the frequency and duration of a wide variety of behaviors and behavioral categories, and age. Also, the subjects were grouped into three age categories (young = 5-10 years, middle = 11-19 years, and old = 20+ years), and these three age groups were tested for significant difference ($p = < 0.05$) using a Oneway Analysis of Variance, when the assumptions of parametric testing could be met, and a Kruskal-Wallis analysis of variance of ranks, when they could not. The specific analysis procedures are discussed in each of the data-based chapters.

Thesis Overview

Social gerontology has been very much a Western concern, and the comparative approach has come only recently. Anthropologists have extended our knowledge of aging patterns to the cross-cultural perspective, and this study is representative of primatologists extending this knowledge to the cross-species perspective. Chapter two is a discussion and overview of the themes in cross-cultural gerontology. This chapter is included to provide an anthropological link between Western gerontology and the study of aging in nonhuman primates. Also, many important concepts and issues in the study of aging are raised in this chapter. Chapter three is a review of the small body of literature on the behavior of aging monkeys.

The next three chapters, chapters four to six, are individual data-based papers, essentially representing three individual studies of the social manifestation of aging in female Japanese monkeys. Chapter four is an hypothesis-testing paper, addressing the popular notion that old monkeys, like old humans, experience a decrease in social interaction. It presents quantitative data and the results of empirical tests of the hypothesized relationship between sociability and age.

Chapter five is exploratory and addresses the possibility that predictable behavior patterns characterize old animals. The notion of role behavior in monkeys, in general, and of *old* monkeys and *old* humans in particular, are discussed. The goal of this analysis is to seek empirical support for the apparently accepted notion that there is a recognizable social category for the aged. Statistical methods are employed in an attempt to uncover any change in behavior which correlates with advanced age. The frequency and duration of all behavioral units are tested against chronological age, which is treated as the independent variable. Significant relationships between age and behavior (for example: old females nap more) are presented and discussed, as are any behaviors which curiously or interestingly do not correlate significantly with age (for example: old females do not move around any more or less than young females). The validity of the role concept for old female monkeys is discussed generally, and in light of these data.

Chapter six also deals with quantitative data, and is exploratory in nature. The analysis focuses upon interactions between the individual and other members of the social group. Here, the possibility that changes in the characteristics of the animal's social network accompany advancing age is explored. The strength of the relationship between the focal animal and each member of its social network is measured by the amount of time which the pair spent together, expressed as a percentage of the focal animal's total social contact time. The identity of the first and second strongest relationship for each focal is explored and compared across the age groups. Also, a number of characteristics of the animals social network (for example, the age, rank, and degree of kin in their social network) are identified and measured, and tested for a possible relationship with the age of the animal. This analysis investigates changes in the interaction pattern of old females, and in the composition of their social networks.

The final chapter, chapter seven, is the conclusion. The results of this study are discussed in terms of the importance of cross-species research and the difficulties with human bias.

This thesis presents the results of an extensive investigation of the social manifestations of aging in one species of nonhuman primate. An important hypothesis is tested and discussed, and behavioral variation is explored from the perspective of individual behavior and from the perspective of the social network. This is a valuable contribution to an important new field, exploring aging from a variety of perspectives, and differing from related studies in a number of ways. First, the expectation of similarity between humans and nonhuman aging is suspended, pending empirical demonstration of this similarity. Second, this study is methodologically distinct in that it has a large sample size, naturalistic conditions, a large body of data collected over all annual seasons, and subjects of *known* age and relatedness. Third, is the recognition that initial exploration and description are vital and necessary parts of an emerging field and borrowed theoretical expectations are avoided at this stage. Fourth, the combination of exploration with the testing of existing but unproven hypotheses helps to make this study a truly thorough and comprehensive introduction to old monkey behavior. It is hoped that it will stimulate further interest in the area, and allow for the formation of new hypotheses from various theoretical schools.

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CHAPTER TWO
THEMES IN CROSS-CULTURAL GERONTOLOGY

INTRODUCTION

Aging and death are common to all human societies, although the social and cultural forms they take may vary widely from society to society. Social gerontology concerns itself mainly with the phenomena of aging in Western industrialized society. European investigators have tested, in their own countries, patterns described for the aged by researchers in the United States, and generally speaking, the aging process is very similar throughout the Western industrial world (Maddox and Wiley, 1976). Non-industrialized and preliterate societies, however, provided interesting contrasts, as well as comparisons.

"If you want your pet theory vetoed, ask an anthropologist" (Fry, 1985:236). Indeed, anthropologists have long played a corrective role in theorizing in the social sciences. Cross-cultural studies play a vital function. Explicit study of the aged has not been the focus of much anthropological inquiry. Rather, the main contribution of anthropologists to gerontology has been the ability to reply to overgeneralized assertions (Marshall, 1985), not just for the purpose of discrediting gerontological theories, but also to aid in their elaboration and specification (Keith, 1981). With the increasing swell of interest in aging, ethnographers have returned to their field notes and have investigated the references to aging in their respective societies. The Amoss and Harrell (1981) and Counts and Counts (1985) collections of essays on aging in various cultures are evidence of this new interest.

Keith (1981) summarized three major themes which characterize the ethnographic contribution of anthropologists to the study of old age in Western society. First, anthropologists provide an emic perspective that often refutes uninformed stereotypes. For example, an insider's view of the Single Resident Occupancy (SRO) residents reveals well fed individuals for whom independence and autonomy are the highest priority, occupying an adaptive niche for a specific category of old people. Misinformed outsiders with urban renewal plans may create hunger and hardship for these elderly because of the lack of an emic perspective. Second, anthropologists document diversity. Realization of the high level of heterogeneity of the aged, their situations, and their responses to them, came relatively late in social gerontology, and lack of this realization still plagues some researchers and theory builders. Third, anthropologists provide a holistic view of the cultural contexts that produce diversity. Cultural context has a powerful influence on the lives of older people. For example, medicalization and the prescription of the sick role for the aged leads to dependence and stigmatization.

Anthropological contributions to the study of age have revealed patterns of unity and diversity cross-culturally. Not all anthropological insights represent corrections to Western generalizations. Some represent continuity whereas others cause the reformulations of existing concepts. This paper will present a brief overview of *some* of the major themes which emerge in this literature. The discussion is not meant to be exhaustive or comprehensive; the selection of themes reflects the frequency with which these themes were encountered in the anthropological gerontology literature, and the degree to which a presentation of that particular theme would provide some ethnographic context for the anthropological study of old monkey behavior. The topics to be covered are the status of the aged; definitions of age; sex-role reversals; definitions of death; gericide; life span versus life expectancy;dependence; and disengagement.

STATUS OF THE AGED

Ever since Simmon's (1945) holocultural study on The Role of the Aged in Primitive Societies, gerontologists and anthropologists alike have been interested in the changing status of the elderly, in societies at different stages of development. According to Simmon's, the allocation of resources and honor to older persons varies from society to society, and is negatively related to the degree of modernization. Higher status for the elderly, he claimed, derives from traditional skills and knowledge, food from communal sharing, exemption from taboos, security from property rights, civil and political power, and general welfare from routine services such as babysitting and cooking.

In 1972, Cowgill and Holmes reiterated the position of Simmons, based on interviews with ethnographers who had studied preliterate peoples first hand. They concluded that the structural changes that occurred with modernization had eroded the traditional position of the elders in society. Previous sources of power and prestige of the aged are lost, in wage economies. A complicated interaction of medical technology, economic factors, urbanization and education, combined to reduce the status of the elderly. For example, young people left and found alternative economic opportunities which undermined the authority and seniority of the old; supernatural sanctions lost meaning and became less threatening; and information could be stored more efficiently than in the brains of the elders (Keith, 1985). Palmore and Manton (1974) argued that a linear decline in the status of the aged did not occur, but that the relationship was in fact curvilinear. That is, the aged lost status with the initial impact of modernization, but in the later stages of modernization, the status of the elderly again improved, with, for example, support from the welfare state.

Some argue that the whole notion of high status for the aged in simple societies represents a kind of 'paradise lost' romanticism. Individual informants may idealize the situation, and there may be a great deal of discrepancy between what people say and what they do. Glascock and Feinman (1981) discovered major discrepancies between the reported prestige and respect of elders, and their actual treatment. They found that 80 percent of their samples had some form of non-supportive treatment, ranging from insults to murder. Likewise, Harlan (1964) reported that in traditional Indian villages, the aged are only deferred to on ritual occasions, and are abused in daily life.

Part of the problem in determining aged status differentials in different societies is the lack of conceptual clarity. Status, in the hierarchical sense, is a multi-dimensional phenomenon. Max Weber (1946) identified three basic elements of hierarchical status: access to valued material resources, respect and prestige, and authority and power. Individuals may hold differential status positions in these different dimensions. In the many articles on status of the aged, any or all of the above elements of status may be discussed, without distinction.

In some cases the aged members of surviving preliterate groups find their status enhanced by revivalistic social change. Old people are repositories of culture, and they have the skills and knowledge necessary to facilitate revivals. Amoss (1981) described a revival movement in the Coast Salish Indians of the American North West coast. The elders, who had initially been threatened by modernization, became highly valued in a religious and cultural revival where only they knew the songs and dances of the past.

Mead (1967) pointed out that, at least in Asian societies, modern medicine presented a mixed blessing for the aged. Prior to the arrival of modern medicine, elders were those who had survived, on their own, in spite of the hardships of life, and they therefore presented a positive image of strength and endurance. Now, the infirm and dependent elderly survive by medical intervention, and sponsor a poor image of their life stage. Simmons (1945) also noted that in preindustrial societies, death is associated with youth and vitality, rather than with old age.

CALCULATION OF AGE

Gerontologists have long known that aging is a multi-dimensional phenomenon involving biological, psychological and social patterns. All are time-related patterns, but chronological age is a poor index of any of the three (Nuegarten and Hagestad, 1976). Chronological age is at best a rough indicator of an individual's position in terms of biological, psychological and social maturity. Compressing age into one dimension, time, masks variability (Butler, 1968). Chronological age is meaningful only in the relational sense of positioning a person with respect to others. Cross-cultural studies of aging have confirmed and elucidated the fact that chronological age has meaning only within the social and cultural context.

Age is given meaning only within a particular culture. Nuegarten and Hagestad (1976) gave the example of a 16 year old girl. This age designation is essentially meaningless without knowledge of the social meaning attached to it. In American society this would likely be a schoolgirl, while in a simple village society, the 16 year old may be a wife and mother. Age is frequently considered to be a natural fact and therefore less desirable for anthropological attention than the more culturally elaborate domains. However, "age is culturally defined and used; age categories are no more 'natural' than kinship groups are biological" (Fry, 1981).

Time itself is cultural, and in many preliterate societies, there is no conceptualization of absolute age calculated by time. Western notions of time have become reified, but they are by no means universal. According to Leach (1961) time is a geometric metaphor of a nonrepetitive straight line, stretching from past to future. This line is divisible into units such as years, weeks, days, and minutes. Western conceptualizations of the life course as an irreversible path between birth and death are reflective of the linear metaphor. Fry (1985) pointed out that other societies perceive time as a wheel or circle where individuals cycle from birth to death, for example the Hindu religious belief in reincarnation. Definition in terms of years is alien to most preliterate societies, and age is determined by meaningful social events, for example, rites of passage. "Time flows, but its stream is uneven and meanders, with its units reflecting human events, not impartial intervals of the orbit of the earth around the sun." (Fry, 1981:222). Individuals place themselves in relation to others (born before or after), or in relation to an irregular natural event, as a member of an age class, and occasionally by some loose reference to the passage of the seasons (Goody, 1976).

Counts and Counts (1985) identified four criteria that are used to classify a person as old. Chronological age is one way, although, as discussed, preliterate peoples do not measure time as Westerners do, so chronological age is largely guess work. Also, chronological age provides little information about physical and mental capacities or social position. The second way in which an individual may be deemed old is based on indications of functional change. Four kinds of physical change may signal the approach of old age. They are changes in facility, in appearance, in activity, and in bodily action. In different societies, people respond in diverse ways to these changes. The Marquesans (Kirkpatrick, 1985) fight the classification of old by surrounding themselves with dependents who attest to the formers' continuing abilities to care for others. The Marshallese (Carucci, 1985) on the other hand, consider the signs of advancing age to be sources of pride. The third criteria used to classify the aged is historical age. For example, an individual may have been born near the time of an historical event which is significant to the society, such as the arrival of the Europeans in Oceania. Social age is probably the most important. A person may be designated as old by virtue of socially meaningful events, such as menopause, or the birth of a grandchild, or great-grandchild. In an age-graded society, individuals may be deemed old by virtue of their membership in a cohort which has moved into the elder stage.

A very important distinction has been made by anthropologists and gerontologists between persons who are elderly, yet healthy and active, and those who are frail and dependent. Anthropologists refer to the intact elderly, and the decrepit elderly (Simmons, 1960), and gerontologists to the 'young old' and the 'old old'. Some take issue with what they perceive to be excessive partitioning of age groups by gerontologists (e.g. Nydegger, 1981:298), however this functional distinction has very real social manifestations, and the study of aging in a cross-cultural perspective has confirmed it. Watson and Maxwell (1977) call attention to the serious shortcomings of ethnographers failing to distinguish between the active elderly and the decrepit old. There is a great difference between being the senior member of a lineage, and being physically or mentally infirm. Some of the discussions to follow will emphasize the salience of this distinction in cross-cultural perspective.

LIFESPAN VS LIFE EXPECTANCY

In the consideration of the aged in cross-cultural situations, failure to distinguish between life span, or Maximum Life Potential (Cutler, 1976), and life expectancy, can lead to real confusion. Life span is species-specific. For *Homo sapiens* life span has been set at approximately 90 years for the past 100,000 years (Weiss, 1981). Variation in life span within *Homo sapiens* was suspected with the discovery of three societies where the people reported extraordinarily long life spans. They are the Vilcabamba of the Andes mountains (Ecuador), the Hunzakut of the Karakoram mountains (Pakistan), and the Abkhasia, of the Caucasus mountains (USSR). Because of the exotic nature of these reports, and the desire for longevity in other cultures, researchers were attracted to these sites to find an explanation for the incredible longevity. Also, these reports were evidence of possible biological life span differences in different human races. However, doubt has been cast on the validity of these claims of longevity. Researchers have been unable to substantiate any of the claims. Mazess and Foreman (1979) examined the records at Vilcabamba, and concluded that the oldest person was 96, and that age inflation began around 70, in a kind of reversal of the 'Jack Benny Complex' in the United States. Since industrialization, significant changes have occurred in life expectancy, primarily due to increased infant survival. However, it is erroneous to assume that because life expectancy is increased, (because more infants are surviving), that the age at which a person gets old will be later. A low average life expectancy does not bear directly on the position of surviving individuals. They do not age faster or die sooner just because population mortality is high in early life.

The proportion of any age class within a society does have ramifications for the situation of individuals within that age class. A large cohort of elders means more political leverage for the cohort, but it also means greater resource use by that cohort. It is often assumed that with modernization and medical advances, the proportion of the aged will increase. However, because the age group most affected by the advantages of medical care is infants, the elderly, despite a small increase in their absolute numbers, actually represent a smaller proportion of the population. The !Kung (Biesele and Howell, 1981) and the Kirghiz (Shahrani, 1981), both of which are relatively insulated from modernization, had an estimated 8 percent of their population over 60. While there are such exceptions, non-industrial societies are generally young societies, with less than 4 percent of the population over 65. Nydegger (1981) argued that the problems faced by an aging population are very different that those faced by a young population, thus the study of the aged in demographically young preliterate groups, while intriguing, is not directly relevant to their concerns.

SEX ROLE REVERSALS

One of the most common themes in cross cultural gerontology is the apparent sex role reversals which occur in later life. Many of the gender restrictions are relaxed, as both men and women cross over into each other's emotional, psychological, social and political spheres. The ethnographic literature is full of passing reference to old women becoming one of the boys, and old men acting like women.

Part of the explanation for this change seems to be a breakdown in the lifetime spheres of influence. Men typically operate in the public domain, but in old age, when physical decline renders them no longer able to meet the demands of the adult male, they lose at least part of their role in the public arena, and thereby find themselves operating in the private or domestic domain, the domain of women. Men may lose their authority in the public sphere, but can still command authority in the domestic realm (Kirkpatrick, 1985). The social world of old men becomes more circumscribed, but the social world of women may expand into the public arena (Sinclair, 1985), as they are freed from the demands of motherhood, and menopause frees them from the stigma of femininity.

Gutmann (1977) suggested that there is a more fundamental psychological explanation for the neutralization of gender differences. He argued for "psychological genotypes, aspects of human nature specific to the aged" (1977:303). He used the apparent universality of sex role reversals as evidence of the biological grounding of this pattern. From surveying Asian, Middle Eastern, African and Amerindian age-graded societies, he concluded that young men should be productive in the here and now, while old men should be productive in the hereafter:

> "there appears to be a certain unanimity among the prescriptions for the various age grades maintained by quite disparate cultures: young men are expected, through their *own* energies, to wrest resource and power from physical nature, from enemy, or from both: old men are expected, through rituals or through postures of accommodation, to coax power – whether for good or malign purposes – from the supernaturals" (Gutmann, 1977:305 italics in original).

A review of the informal and personally expressive behavior of old men confirmed the formal pattern described above, and led Gutmann to suggest that men age psychologically along an activity-passivity continuum. As an example, he cited Quain (1948) as reporting that in Fiji, aging men bestow time and affection on the women of the household, and their productive efforts shrink to the household garden. Women reverse the order, moving from passive mastery in early life to active mastery in later life. Early life passive mastery is due to their role in the private domain, and their dependence on, and deference to, their husbands. In later life, possibly because menopause has released them from their physically evident feminine and mother role, women become more domineering and less willing to trade submission for security. Goody (1962) reported that because post-menopausal women had 'become men', they were allowed to wash corpses.

Similarly, Levy (1967) described the right of post menopausal Amerindian women to participate in ritual practices previously forbidden to them.

Gutmann's (1975) explanation for this neutralization of sex roles is that gender is not a function of sex, per se, but rather of parenthood, and with the passing of parental duties, the gender distinctions fade. "Thus, neither sex is the final custodian of the qualities that we choose to call 'masculine' or 'feminine'" (Gutmann, 1975:181). Men dominate the public realm because childbearing and rearing links women to the domestic (Ortner, 1974). Females surrender aggressive tendencies in order to provide the emotional and psychological security for the children. Men surrender intimacy and dependency in order to provide physical support. When active parenthood is past, each recaptures what was lost or repressed. Because these conditions of parenthood, specifically motherhood, are universal, so are the subsequent late life role reversals.

Another frequently argued point is that aging is easier for women than for men. In the anthropological literature, women are described as aging with less difficulty that men. Because women play out their entire lives in the domestic sphere, they are said to be faced with less traumatic transitions in old age. The bonds of affection between women and their offspring sustain them in old age, whereas the old men, not having fostered strong emotional ties, find diminished personal satisfaction in the domestic domain (Keith, 1985). Another possibility is that women actually change roles frequently throughout life, as they cycle in and out of pregnancy and lactation, and deal with menstruation and menopause and they are thus much better prepared to deal with transitions in later life. In other words, females are socialized to be more flexible (Cool, 1981).

DEPENDENCE

As discussed in Chapter 2 of this thesis, the notion of dependence is intimately linked with our notions of old age, and given the interindividual dependence that results from a division of labor, subsistence specialization, and production and exchange, dependency of the infirm, at any age, is a panhuman characteristic. However, dependence can vary in the cross-cultural context (see Fry, 1985). In Western societies the independent/dependent distinction is very much a positive/negative one. Independence is highly valued in Western societies, dependence is feared and avoided, especially by the elderly. Reciprocal exchange is an essential hallmark of the human character. Independence is characterized by balanced giving and taking, dependence by unreciprocated taking. Non-reciprocity is tolerated in certain situations, such as illness or infancy, however in no known society is chronic dependence rewarded with prestige.

Even in Western institutions designed to care for dependent individuals, differentials in reciprocity lead to very different treatment and attitudes by staff. Kayser-Jones (1981) reported that in Scotland, institutionalized patients slipped small gifts to individual staff members. This resulted in better care, and more respect and esteem from the staff. American institutions on the other hand were more characterized by neglect, since patients, for some reason, had little opportunity to reciprocate by giving to the staff.

Fry (1985) argued that while dependence is a world wide phenomenon, it is intensified by modernization. The economically and residentially independent nuclear family, age limits on production (labor), and a cash economy all intensify the situation for a dependent. Reciprocity in the modern world is characterized by immediate return. In non-industrial societies, production is not limited by age norms, nor is it defined in terms of cash value. Various functional abilities enable even the very old to make some contribution to the household. Moreover, reciprocity is less temporally defined, so give and take need not be immediate. The elderly were involved in unreciprocated exchange when raising the children. Finally, a dependent individual need not be the responsibility of a single individual, because of the extended family residence.

GERICIDE

Tales of Eskimo groups abandoning their elders on ice floes are frequently cited as exotic examples of the shocking treatment of the aged in preliterate societies. It is the other side of the 'paradise lost' notion of the elders in simple societies being accorded far more respect and prestige, and better treatment, than they do in Western society. The attention paid to such wildly exotic reports far outweighs their ethnographic or anthropological significance, however non-supportive treatment of the aged has been reported for many societies (Glascock and Feinman, 1981). Neglect, abandonment, and even murder, do occur.

Maxwell and Maxwell (1980) described numerous cases of contempt for the elderly in a cross-cultural survey. Here is an example of the significance of the intact versus decrepit distinction: in virtually all cases, the contemptuous treatment, sometimes death hastening, was directed toward the decrepit elderly. Loss of family support is cited as the most important element in the onset of such treatment.

These cases are not necessarily all examples of what we consider to be contemptuous behavior. Guemple (1980) pointed out that in an emic view, social identities are indestructible, and the victims do not really die. Or, as discussed by Counts and Counts (1985) death hastening treatment may have much to do with the cultural definitions of life and death (see next section).

One factor which has been associated with reported negative treatment of the elderly is a harsh environment. Eskimos inhabit one of the harshest environments in the world, and this has been linked to a high incidence of hysteria and psychosis. Gutmann (1977), however, argued that a cultural personality type is to blame, not a harsh environment. He claims a correlation between the emotional advancement of the people, and good treatment of the elders. In the Ammassalik of Greenland (studied by Mirsky, 1953) the aged are cared for only if their sons choose to care for them, which they may not, because of emotional and psychological underdevelopment. These people are reported to be interested only in power and possession, are dangerously egocentric, and are not objects to one another in a mature, internalized sense. The Nunivak Eskimo, (studied by Lantis, 1953) offer an interesting contrast. While inhabiting an equally harsh environment, the Nunivak are described as emotionally advanced, with warm interpersonal ties at all levels. They have the capacity for object relations. In societies that sponsor a selfish spirit, the aged and other infirm are vulnerable, because in the absence of immediate productivity, they lose their position in the minds of the others. In the absence of object constancy, the elder is not seen with historical continuity. The person they once were is forgotten. Societies which foster an altruistic compassionate spirit, and the formation of internalized objects, provide security to vulnerable individuals. A dependent elder in such a setting is seen not just as a weak and ugly old person, but also as the vital and sustaining parent they once were. Having attained true object status, the aged transcend their immediate circumstances in the eyes of the others. In these societies the aged receive good treatment not because they command the respect and obedience of their children, but because they command their love.

DEFINITIONS OF DEATH

Definitions of death vary across cultures, and even in North American societies, with medical advances, authorities find themselves grappling with the definition, or re-definition of death. Life and death have typically been viewed as clearly demarcated, mutually exclusive, non-reversible, fully opposite conditions. One is the complete absence of the other. However, anyone who has witnessed the death of a person who dies of illness can testify that the boundary between life and death is not so clear cut. Death is actually a transition, a process. As medical technology makes it possible to sustain certain biological systems once others have ceased to operate, it becomes more common for individuals to be halted in the process of dying. Western medicine now specifies the death of certain systems. A person may be brain dead but the heart still beats. The point at which a person is determined to be clinically or legally dead has very controversial ramifications, in terms of, for example, organ donation. Western medicine, indeed, Western society, is coming to terms with the fact that death is not always a sudden, all or nothing matter. Decisions have to be made as to when an individual has completed dying, and can be treated as dead. This ambiguity leads to some very ethically ambiguous circumstances, and even to some potentially macabre decisions.

In preliterate society, the distinction between life and death is generally not distinct and irreversible. According to Counts and Counts (1985), the

> "peoples of the South Pacific have long recognized that rather than being a single fixed event, death is a transforming, reversible process whose boundaries may lie to either side of the occurrence that we call clinical death" (1985:2).

As a result of the very different conceptualization of death, ethnographers often include reports of gruesome treatment of the ill and infirm. The distinction between the intact and the decrepit clearly has relevance here. It is always the latter category which fall prey to classifications such as the "already dead", and to whom death hastening treatment is directed (Glascock and Feinman, 1981). Mourning ceremonies prior to complete physical death are not uncommon, and the very old may, before breathing and heartbeat has stopped, be left alone and untended to die (Van Arsdale, 1981) or even be buried alive by their children (Van Baal, 1966). Counts and Counts (1985) described a senile village leader whose children completed mortuary ceremonies, thereby rendering the man socially dead.

Definitions of death can clearly have very real influence over the treatment of the elderly, specifically the 'old old' or the 'decrepit old'. However this treatment need not always be bad. In some societies, the decrepit old are revered, precisely because they are close to death. The dead generally become members of the spirit world, so the very frail are treated with awe and respect because they are soon entering, or may even be overlapping with the spirit world. They may be able to attract or channel spiritual power, benevolent or malevolent, into the world of the living.

DISENGAGEMENT

A number of attempts have been made to document disengagement theory (Cumming and Henry, 1961) cross-culturally. Although the theory attempts to be culture-free, it has not received the support of most ethnographers. Disengagement is widely held to be a by product of urban industrial society (Cowgill and Holmes, 1972).

Age-graded societies may set parameters for inclusion or exclusion in a wide range of activities based on age, thus creating clearly demarcated age groups (Nuegarten and Hagestad, 1976). Theoretically, societies such as these may contain very small age cohorts, which, if excluded from interaction, could lead to isolated or disengaged individuals. However, I am aware of no report of truly isolated elderly as a result of age-grading. Because of the small group size and predominance of extended family residence, in preliterate society, physical and social isolation may in fact be difficult to achieve.

Reported cases of actual withdrawal or disengagement always involve the decrepit old. This may be a function of the nearness of death. These individuals may be considered almost dead, and as described above, are treated as such. Or withdrawal and isolation may result from fear of the individual due to their nearness to and connection with the spirit world. Vatuk (1980), investigated the possibility of withdrawal of the aged in a small village, and reported that even where age withdrawal is held as a cultural value, it does not mean cessation of all social activities. Rather, the elderly, including the intact elderly, freed from many everyday burdens, should be more concerned about spiritual affairs.

CONCLUSION

The cross-cultural perspective is an important one for the testing of general hypotheses about human life and development. The comparative method enables us to determine whether a social or behavioral pattern is universal to human society, or whether it is an artifact of one specific cultural circumstance. This is essential in understanding the range and variation of human behavior, and in understanding the social and cultural parameters which produce variation. Disengagement is an example of a behavioral pattern which was purported to be universal and "culture-free", yet the comparative approach proved it to be an artifact of Western industrialized societies. In gerontology, this is important not just as a social scientific issue, but also because the aged in Western society pose a very real social problem. The claim of universality may lead to an altered perspective on the possibility of social change, as universal patterns are often assumed to be grounded in nature, and hence to be unalterable. The cross-cultural comparison in gerontology helps to identify culturally-specific behavior patterns, and the cultural parameters which determine their manifestation.

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CHAPTER THREE
LITERATURE REVIEW: OLD MONKEY BEHAVIOR

Laboratory studies of the effects of aging on physiological (especially endocrine) processes of primates are numerous (for example see Bowden 1979 collection of papers). Of more direct interest to behavioral scientists are the equally numerous studies of the effects of aging on perception, memory, cognition, and learning (for example, see Davis et al. 1964; Fletcher and Mowbray, 1962; Johnson and Davis, 1973; and Marriott and Abelson, 1980). If any generalization can be made from this research, it is that there is a tendency for performance in these areas to decline in old animals. Similarly, laboratory investigation of how sexual behavior changes with old age suggests a general decline, at least for males (Chambers and Pheonix, 1982). Jenson et al. (1980) found that the sexual behavior of older bonnet macaque females (*M. radiata*) is qualitatively similar to that of younger, mature females, but that older females received fewer copulations than younger ones (Jenson et al., 1982)

Laboratory studies of the behavioral changes associated with old age in primates suffer from a number of handicaps. First, the number of old animals is very low, since many lab studies of physiological issues ultimately require that the animals be sacrificed. Where old animals do occur, they tend to be almost alone in their age class. These laboratory animals may exist in a sort of social 'vacuum', without the complex social network and interplay of social variables within which primate behavior normally occurs. In other words, there is the familiar problem of generalizing from studies of small numbers of animals in highly unnatural conditions. Furthermore, these animals have spent most of their lives in captivity, and were often heavily manipulated throughout this time. It is impossible to say how the behavior patterns of laboratory animals may have been altered by the time they reach old age. Another very important point is that the *exact* ages of these presumably very old animals is generally not known. The majority of old animals in captivity were wild-born, brought into captivity some years later. Age at arrival in a lab or captive setting is therefore estimated. Even though the margin of error may be only 2 to 3 years, it is unfortunate that the values of the independent variable in all these studies are not exact.

Field studies which make reference to the behavior of aged animals suffer this problem of age estimation to an even greater extent than do lab studies. In the lab, there is at least certainty in terms of the minimum age of the animal, that is, the number of years in captivity *is* known exactly, and the estimate of age at arrival is added to that. Estimating the ages of animals in the wild is much more problematic, and the margin of error will increase with the age of the animal. With animals who are obviously *smaller* than the majority of the troop, it is fairly safe to assume that they are not fully mature. However, once skeletal maturity has been achieved, there is little in the way of predictable appearance changes. Physical features such as wrinkled skin and scraggly fur are highly subjective and variable criteria which cannot be relied upon to accurately assess chronological age. It is clear from semi-free ranging groups of animals of known age, such as the Arashiyama West troop, that looks can be very deceiving.

References have been made, by field researchers, to the behavior of animals who are assumed to be aged. Maxim (1979) reviewed some of these from the perspective of the role that aging animals play in the social group, and the effects of aging on the individual's status within the group. He concluded that 1) almost nothing is known about the role of aged animals in solitary and parental family species; 2) in age-graded and uni-male societies, aging animals maintain status through affiliative bonds, whereas those who have had primarily dominance relations as opposed to affiliative female-female bonds (such as hamadryas females) become progressively isolated with age; and 3) in multimale troops, individuals maintain status in old age by lifetime kinship and affiliative ties. Maxim's organization of primate societies is based on Eisenberg et al.'s (1972) five type classification. It should be noted that Maxim's summary is based on some early research, the results of which are now recognized to rest on a number of oversimplifications and unfounded assumptions. An example is the notion that all primate societies can be adequately and accurately categorized into types based on increasing male tolerance of other males.

Maxim's own study of captive pig-tailed monkeys was valuable. His data did not support the hypothesis of social disengagement in old monkeys, but he did find evidence that the behavioral sequences of older animals were more stereotypically organized that those of younger monkeys. Similarly, Fitts(1976) found that knowledge of the preceding behavior reduced the uncertainty of predicting the next behavior in older animals, but was unable to document any evidence of social disengagement.

Waser (1978) described the post-reproductive survival and behavior in a free-ranging female mangabey. This old female was described as being relatively inactive and somewhat peripheral, and was less often involved in grooming than were other females. She interacted aggressively less than other females, and she was observed receiving aggression primarily by adult males. She was never mounted by adult males, and rarely presented to them. In at least two behavioral interactions (grooming and embracing), this female was seen initiating the interaction significantly less often than were the animals with whom she was interacting.

Reports such as Waser's (1978) help to stimulate interest in aging animals and even suggest aged behavior patterns. However, extreme caution must be used in the interpretation of observations where the sample size is one, and the critical variable, (old age), is estimated on the basis of appearance and vocalizations alone.

Hrdy (1981) contrasted the behavior of old female macaques and langurs. She pointed out that the matrilineally-organized macaque societies tend to preserve the status of old females, at least in high- and middle-ranked lineages. Langur troops appear not to be matrilineally organized, in spite of the fact that females in a langur troop are, on average, more closely related to each other than are the females of a macaque troop. Hrdy explained this difference in the relatedness of the females as the result of different breeding systems. In a macaque troop, several reproductively active males are present. In a langur troop, on the other hand, there is often only one reproductively active male fathering infants. Female langurs of the same age share not only the same father, but have closely related mothers as well. According to Hrdy, this is the key to understanding why old female langurs fall in rank and avoid close contact with others, although they participate in troop and infant defense: old females have more to gain by working on their inclusive fitness. In this sense, natural selection can be seen as favoring the development of special behavior patterns in old females. Hrdy's study of old female langurs, like most others, suffers from lack of accuracy by estimating ages in the wild based on appearance.

Perhaps the two most relevant studies of the behavior patterns in aged animals are those of Nakamichi (1984) and Hauser and Tyrell (1984), both of which deal, at least in part, with free-ranging animals of known age. According to Nakamichi's observations on Japanese macaque females of known age, females rest more, spend more time alone, and are less likely to groom others. He did not observe any marked decline in the rank of old females. Hauser describes a similar pattern of reduced social interaction and increased rest time for captive pigtailed and semi-free ranging Japanese monkeys.

Explanations for the behavior of aged monkeys, as reported from these studies, have been offered. Hauser (unpublished manuscript) offered declining health and energy as the proximate explanation for the observed disengagement of aged females, but otherwise most attempts to explain this behavior look to the theory of evolution for ultimate explanations. The principle of kin selection is frequently called upon to account for the specific behavior pattern of aged monkeys (e.g. Hauser, in press; Hrdy, 1981; and Partch, 1978). Hauser observed that the remaining few social interactions of aged females are with kin and other old animals. Kin interactions are viewed as the maximization of inclusive fitness; whereas interactions with other old females are explained by the principle of reciprocal altruism.

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CHAPTER FOUR
DISENGAGEMENT IN OLD FEMALE MONKEYS

INTRODUCTION

In recent years there has been an increase in the attention paid to the behavior of old monkeys in captivity and in the wild. This interest has no doubt been stimulated by the rapid growth and diversification of social gerontology; behavioral scientists from a wide variety of disciplines have turned their attention to the phenomenon of aging.

Studies of the social behavior of aging monkeys in free or semi-free ranging conditions are still limited. Waser (1978) described the behavior of one old and apparently post reproductive female mangabey in the wild. The description of this female emphasized her degree of peripheralization. Hrdy(1981) described and discussed aging in free-ranging langurs and macaques. Old female langurs were described as 'altruistic', whereas old female macaques were described as 'nepotistic'. This typology is based largely on the differing systems of dominance rank in the two genera. In macaques, a females dominance rank is primarily determined by genealogy, or lineage membership, and is more or less fixed for life. Old female macaques therefore enjoy status continuity in old age. Langur troops are not segmented into matrilines, and dominance interactions involve individuals, not alliances. The macaque pattern of closely-related females defending one another against less closely-related females is absent in langur society. Observations at Abu, the study site in India, led Hrdy to report that old females were among the lowest-ranking adults. Old female langurs are also reported to withdraw socially, as are macaques, although "among macaques, unlike langurs, reduced social involvement of old females is not necessarily accompanied by a fall in rank" (Hrdy, 1981:67).

Old Japanese monkeys have been studied most, probably due to the wealth of longitudinal data available. Hauser and Tyrell(1984) compared old captive female stumptailed macaques with old female semi-free ranging Japanese macaques. They reported that old females were less active and were involved in fewer social interactions than were young females, due to a social withdrawal on the part of the old females. Nakamichi (1984) explored various aspects of the social behavior of old females in a free-ranging provisioned Japanese monkey troop and reported a positive correlation between the occurrence of rest and age and a negative correlation between the occurrence of auto-grooming and age. He concluded that the "behavior of old females was characterized by a marked decrease in social interactions" (Nakamichi 1984:195).

Clearly the one emerging theme from these early reports on aging monkeys is that old animals, particularly old females, experience a decrease in social interaction. Two studies involving captive groups, however, were unable to find any evidence of disengagement (Maxim, 1979; Fitts, 1976). Empirically, then, this question of old females and disengagement is controversial. Resolution of this controversy is important for a number of reasons. First, some authors (e.g. Hrdy, 1981) have used this variation in behavior between aged and non-aged females as evidence of the evolution of specific behavior patterns for aged animals. Hauser and Tyrell (1984:32) argued that old females withdraw from social interactions due to an increase in the costs associated with establishing and maintaining social relationships.

Perhaps more importantly, evidence of disengagement in monkeys would parallel what has been reported (though not confirmed) to occur in humans (Cumming and Henry, 1961). According to disengagement theory, the key to successful aging is the mutual withdrawal of the individual and society, from each other, in preparation for the ultimate withdrawal of the individual by death. The theory suggests that withdrawal of the aged is inevitable and universal, and predicts that disengagement, as expressed in reduced life space and a reduction in the quality and quantity of social role activity, will be associated with increased morale. Disengagement theory may be seen as a systematic alternative to the long standing notion that the key to a happy and successful old age is to stay active and to stay socially involved.

Disengagement theory has had a very long and very controversial history in social gerontology, and this is not just a scientific issue. Social gerontology also involves social policy and social program planning. If primatology is to provide cross-specific information on directly comparable phenomenon, such as the possible tendency for aged individuals to experience withdrawal or isolation from the social world, then it is important that the phenomenon be thoroughly investigated and tested under the best possible methodological conditions. It should be clarified that disengagement theory predicts, for humans, that increased morale will be associated with decreased social interaction. In testing the disengagement hypothesis in monkeys, it is clearly not possible to assess morale. It is the reported behavioral pattern of decreased sociability which is being tested here.

The present long-term study of the social behavior of aged female Japanese monkeys was undertaken in 1985-1987 in order to further investigate the possible relationship between old age and sociability. The results are based upon a large body of data collected on a large sample of animals living in a normal (semi-free ranging) social group. Exact demographic data (for example, ages) are known.

METHODS

The Study Troop

The study troop, a semi-free ranging troop of Japanese monkeys, is located on a large ranch near the town of Dilley in south Texas. Dilley is halfway between San Antonio and Laredo, and the ranch is located in an area that is predominantly scrub-brush.

The animals, numbering close to 400, live in a 58 acre area enclosed by an 8 foot electrified fence. All animals are identifiable by a facial and leg tattoo. They are provisioned daily with cattle cubes and grain, and also forage on natural flora. The enclosed area in which the animals tend to stay contains 2 large fields, a bushy ravine running the length of the enclosure, and 2 large ponds, one permanent and one seasonal, for swimming and drinking. Alternative water sources are located throughout the enclosure in the form of running spigets. At least once a year the fields are planted with domestic grain for forage. Also the animals consume the leaves and beans of the the mesquite, as well as seasonal native growth, such as wildflowers in the spring.

Scientific observations on the troop began in 1954 in Japan. In 1966 the provisioned troop split, and plans were made to relocate one of the daughter troops which had become a problem to the local inhabitants. In 1972 the Arashiyama B troop was transplanted to Texas in its entirety. Complete birth, death, and geneological records continue to be maintained on a daily basis. The animals exist with a minimum of human intervention, and are habituated to the presence of at least one behavioral researcher.

The Subject Animals

The sample consisted of 40 females, ranging in age from 5 to 30 years old. Since Japanese macaques have a Maximum Life Potential (Cutler, 1976) of approximately 30 years, those 20 years and older were deemed to be in the third trimester of their lifespan. Eighteen females in the troop were 20 years of age or older, and all of these animals were included as subjects. These 18 animals therefore constituted the aged animals. A comparative group of 22 animals ranging in age from 5 to 19 years was also sampled. At least one animal from each birth cohort was included, and beyond this sampling for age, an attempt was made to sample representatively across dominance rank.

Data Collection

440 hours of focal animal data (Altmann, 1974) were collected between March 1986 and May 1987. Focal sessions were 30 minutes in length, 22 sessions were collected for each subject, and each female in the sample was tested once before another round of tests began. Observations were conducted throughout the day, in order to control for any possible effect of time of day, as well as throughout the year, in order to control for seasonal variation. The animals were observed from a distance of approximately 6 meters, which provided excellent visibility without interference. All behavior, including all interactions, were recorded, complete with the time of onset and completion of each behavior.

In the event of more than one other animal interacting with the subject simultaneously, for example a mother grooming her infant while another adult is grooming her, it was necessary to select only one interacting animal for entry on the focal animal sheet. Because interactions with the adults in the society were considered a better indicator of sociability than were interactions with juveniles, and because infants and juveniles were not all distinguishable to the researcher, the adult in the interaction was consistently selected for entry on the focal animal data sheet. Unambiguously equal interactions involving two other adults were very rare, and when they occurred, the incumbent, or the animal who was there first, was recorded.

Data Analysis

From the large body of behavioral data, two different measures of an animal's sociability were obtained.

Network Size — The first sociability score was a simple count of the number of others with whom the subject was observed to spend time. The unit of measure for this dependent variable is therefore individual monkeys. This score was derived from the total list of others with whom the animal was seen to interact. The list of possible social or interactive behaviors can be divided into two groups: states and events. A state behavior is one which requires more than a few seconds to perform, such as sitting in body contact or grooming. Event behaviors, on the other hand, are instantaneous, such as a vocalization, a threat, or the displacement of another animal from a preferred resource. Instantaneous interactions such as a single displace or a single threat were not considered to necessarily indicate membership in the animal's social network. A more conservative list, then, was derived from the total number of interactants, which included only those others with whom time was spent in interaction. A minimum of 15 seconds was required in order for the state behavior to be recorded.

Social Contact Time — The second sociability score was a measure of the total amount of time that the animal spent in social contact. The unit of measurement for this dependent variable is minutes. Since each animal was sampled for the same amount of time, these raw scores were directly comparable. Female Japanese monkeys spend time in social contact in two major ways – sitting in body contact or engaging in social grooming. The time in social contact score was therefore the total number of seconds in which the animal was in body contact with another, either grooming or sitting. Sitting near another animal could be an indication of social contact between the two animals, but because of the possibility that nearness was a function of a third factor, such as food, water, shade, or another animal, only unequivocal social contact expressed by sitting in direct body contact was included in the analysis.

Social network size and social contact time were chosen as the two operationalized measures of sociability because they were the most appropriate for measurement with the Japanese monkeys, and because these two, time in social interaction and number of interactants, are specifically itemized in disengagement theory (Cumming, 1975).

Due to the necessity of recording juvenile interactions only when they occurred in the absence of another adult interaction, the record of juvenile interactions was not complete, nor was it independent of the adult interaction record. Interactions with juveniles were therefore not included in this analysis. Furthermore the limitation of sociability scores to adults only resulted in a more conservative measure of an individual's sociability, since juveniles are numerous in the troop, and the inclusion of juveniles and infants could dilute a variation in sociability within the adult population.

The goal of the analysis was to test the hypothesis that old animals experience social disengagement or isolation. This goal was met by investigating the relationship between the age of the animals and their two sociability scores. First, the age and sociability scores were plotted on scattergrams to provide visual representation of the relationships. Next, the extent to which the two sociability scores were related to age was measured mathematically using the Pearson product-moment Correlation, and this correlation was tested for statistical significance. Finally, the sample of 40 subject females was broken down into young (5 – 10 years), middle (11 – 19 years), and old (20+ years), and these three age groups were tested for significant differences in their sociability scores.

The distribution of the scores within each of the two sociability variables was studied for the purpose of identifying outliers and determining the appropriateness of parametric versus non-parametric statistical tests. The conditions for the more rigorous parametric tests were met, and a oneway Analysis of Variance was therefore used to test for significant differences between the scores for the three age groups, on each of the sociability scores.

RESULTS

Table 4.1 presents the age and sociability data for the total sample of 40 females. Summary statistics on each of the sociability variables for the total sample and for each age group, are presented in Tables 4.2 and 4.3.

The social network size for the complete sample ranged from 2 to 13. In other words, animals in the sample were observed to spend time with anywhere from 2 other monkeys to 13 other monkeys, a range of 11. The mean social network size for the total sample was 8.58. These figures are also presented for each of the three age groups. The animal with the smallest social network score (N=2) was an aged animal, and the animal with the largest social network score (N=13) was a young animal, however, as is evident from the table, large networks were also seen in aged animals, and small networks were found in young animals. The middle age group showed a smaller range of scores than did either the young or the

Table 4.1
Age and Sociability Scores
Complete List of Subject Females

I.D.	AGE	SOCIAL NETWORK SIZE	MINUTES SPENT IN SOCIAL CONTACT
5	17	12	175.38
6	22	7	175.98
8	14	9	342.80
11	21	8	169.93
26	20	3	202.20
32	22	11	209.40
33	9	13	226.00
36	23	6	86.867
38	25	11	277.27
39	30	10	182.63
40	21	9	164.83
49	20	8	241.48
52	17	7	161.95
58	19	7	215.27
60	18	9	243.97
76	10	9	185.30
77	22	8	249.47
85	21	11	284.98
86	24	9	247.27
90	22	2	67.517

I.D.	AGE	SOCIAL NETWORK SIZE	MINUTES SPENT IN SOCIAL CONTACT
91	10	7	246.92
92	23	12	166.97
97	22	7	220.70
99	26	7	76.20
111	12	8	104.03
114	15	7	103.47
117	20	11	218.12
123	11	6	132.20
125	11	9	124.62
133	21	10	209.37
142	18	8	189.60
157	16	8	125.23
161	14	11	172.73
227	8	8	97.23
255	9	8	96.70
274	7	7	131.37
284	8	13	276.58
307	6	10	164.60
356	5	13	138.40
361	5	4	209.03

Table 4.2
Summary Statistics
Social Network Size

	MINIMUM SCORE	MAXIMUM SCORE	MEAN	STD DEV
Total Sample N=40	2	13	8.58	2.53
Aged Sample N=18	2	12	8.33	2.74
Middle Age Sample N=12	6	12	8.42	1.73
Young Sample N=10	4	13	9.2	3.05

Table 4.3
Summary Statistics
Social Contact Time

	MINIMUM SCORE	MAXIMUM SCORE	MEAN	STD DEV
Total Sample N=40	67.52	342.80	182.86	63.74
Aged Sample N=18	67.52	284.98	191.73	63.75
Middle Age Sample N=12	103.47	342.80	174.27	68.70
Young Sample N=10	96.7	276.58	177.21	62.22

old. The mean social network size for each of the three age groups were very similar, with only a small decrease from the young to the middle to the old.

Table 4.3 presents the same summary statistics for the second sociability score: time spent in social contact. The scores for the total sample ranged from 67.52 minutes to 342.80 minutes. A total of 11 hours of focal animal data (660 minutes) were collected on each subject, therefore these indicate the number of minutes spent in social contact out of 660 minutes of recorded observation. It may appear that the animals are not particularly sociable, however, recall that this measure of sociability is a conservative one, including only unambiguous incidences of social contact expressed by actual physical contact between the individuals for at least 15 seconds.

The score for the least amount of time spent in social contact (67.52 minutes) is that of an old female, however young and middle age animals also show cases of relatively little time spent in social contact. The highest score (342.80 minutes) was that of a middle age animal. In looking at differences in the mean for each of these age groups, the aged group shows the highest score for time spent in social contact.

Visual representation of the relationship between age and each of the 2 sociability scores is presented in Figures 2.1 and 2.2. It is clear from these scattergrams that little, if any, relationship exists between age and either sociability variable. The actual correlation coefficients which indicate the relationship are presented in Table 4.4. Clearly there is little to no relationship between age and the number of other adults with whom the individual interacts ($r=-0.08$, $p=0.62$), or between age and the amount of time the subject spends in social contact ($r=0.13$, $p=0.44$).

Although it seems clear from Tables 4.1 and 4.2 that the three age groups were very similar in their sociability scores, statistical tests were performed to confirm this. The results of the oneway Analysis of Variance are presented in Tables 4.5 and 4.6. There is no evidence from these tests that any significant difference occurs among the three age groups for either of the sociability scores.

Figure 4.1
Scattergram
Age and Network Size

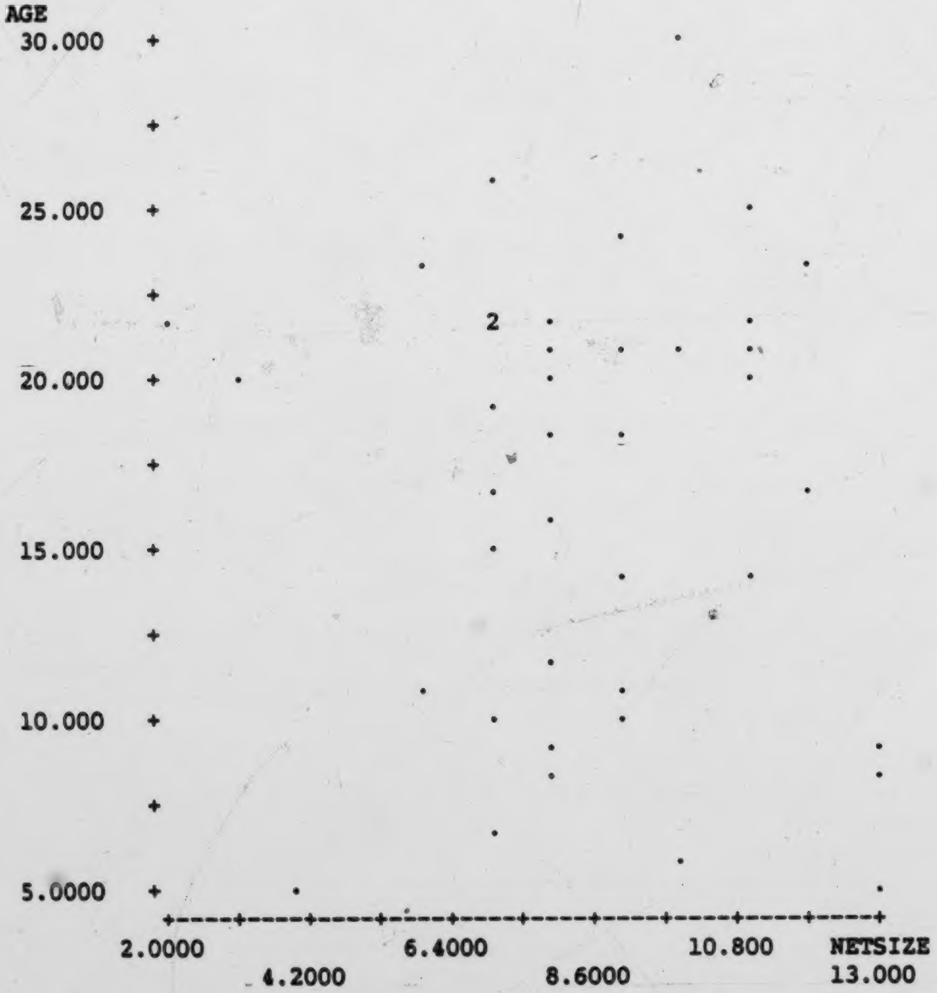

Figure 4.2
Scattergram
Age and Social Contact Time

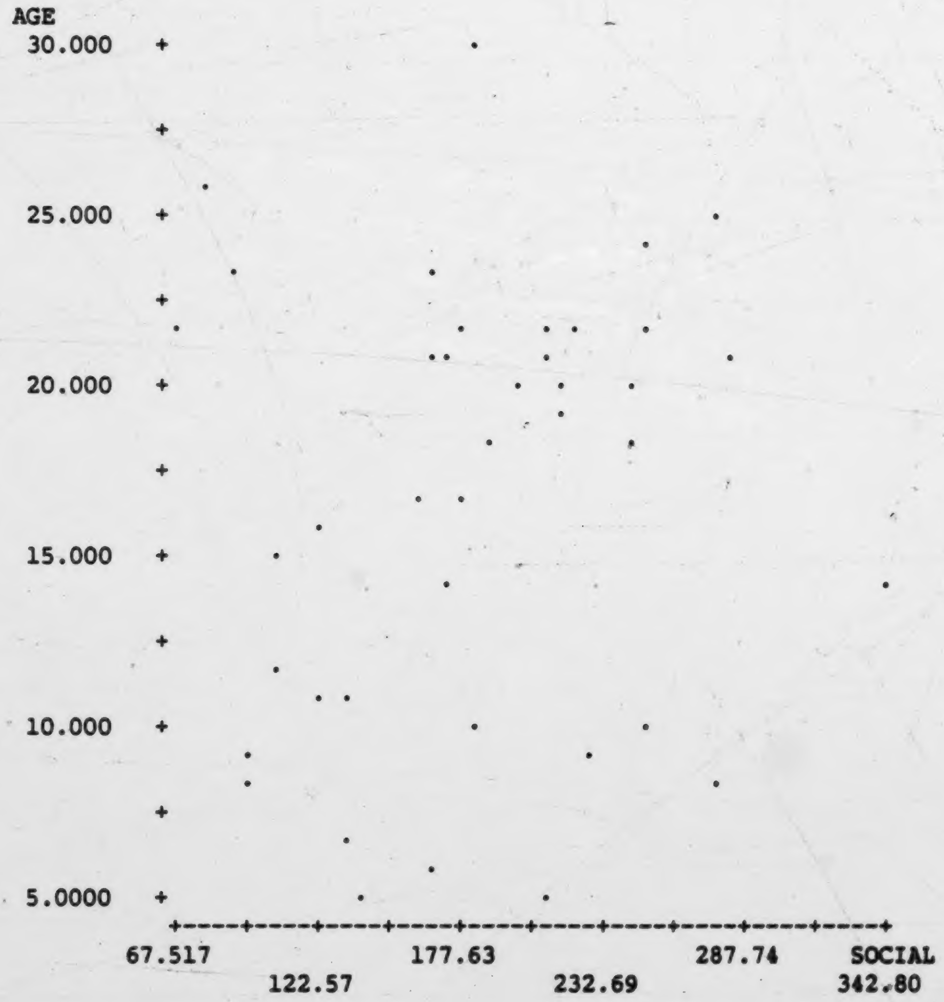

Table 4.4
Results of the Pearson product moment Correlation
Age by Network Size and Social Contact Time

	r value	p value
Social Network Size	-0.08	0.62
Social Contact Time	0.13	0.44

Table 4.5
Results of the Analysis of Variance
3 Age Categories
Social Network Size

	YOUNG (5-10)	MIDDLE (11-19)	OLD (20-30)	TESTS	P VALUE
Mean	9.2	8.4	8.3	F=0.39	0.67
Variance	9.3	2.9	7.5	F=1.65	0.19
N	10	12	18		

Table 4.6
Results of the Analysis of Variance
3 Age Categories
Social Contact Time

	YOUNG (5-10)	MIDDLE (11-19)	OLD (20-30)	TESTS	P VALUE
Mean	177.21	174.27	191.73	F=0.31	0.74
Variance	3870.9	4719.8	4064.1	F=0.55	0.95
N	10	12	18		

DISCUSSION

This study revealed no consistent pattern of decreased sociability in aged female Japanese monkeys. Chronological age does not account for any significant amount of variation in the amount of time spent in social contact, or the number of different other animals with whom time was spent. There is no evidence here that aged animals experienced any disengagement or tendency toward social isolation.

Other studies have reported a pattern of reduced interaction for aged animals. Both methodological and conceptual factors may account for the discrepancy between the results of this study, and those of earlier studies.

Due to the nature of the subject matter, and to the recentness of interest, certain methodological shortcomings characterize much of the early research. In order to demonstrate a pattern such as decreasing sociability of animals in the later portion of the lifespan, large samples of animals of known age are needed. This has not always been the case with reports of aging monkeys. Clearly, identification of aged animals based upon behavior and appearance, as was done by Waser (1978) and Hrdy (1981) is problematic. The expectations based on human perceptions may account for some reports of old monkey behavior in the wild, especially where chronological age was not known. It is possible that reports such as Waser's (1978) and Hrdy's (1981) are based on observations of a small set of truly old animals. It is also possible that these were old *and* disengaged or isolated animals. However, there is no way to know if these are exceptional or unusual animals, because aged animals with normal sociability patterns or normal appearance would not have been considered.

The studies by Nakamichi (1984) and Hauser and Tyrell (1984) did not suffer these same methodological problems. Both deal with somewhat larger samples of animals and in both cases exact ages are known. Hauser and Tyrell observed 10 aged females (18–28 years old) and 8 young females (8–14 years old). Nakamichi observed a total of 14 adult females ranging in age from 11 to 29 years of age. Eight of these animals were over 20 years of age. Both studies were conducted during the spring and summer months.

Marked decrease in the social interaction of aged females was reported by both of these studies. The discrepancy between these findings and those of the current study may be due in part to differences in sampling. Both sampled a smaller number of animals for a much shorter period of time. Data collection during the spring and summer only may yield some seasonally specific results.

Disengagement Theory

It is also possible that conceptual or theoretical factors are involved in the reports of reduced sociability. Disengagement theory (Cumming and Henry, 1961) dominated social gerontology for much of its history. According to disengagement Theory, successful aging is characterized by the mutual social and psychological withdrawal of the individual and the society in preparation for the removal of the individual from society by death. This theory both reflected and reinforced the popular notion that in old age, people become increasingly isolated from society.

Problems with disengagement theory abound. As a functional explanation for the observation that the elderly withdraw from society, disengagement theory has not been supported by empirical research. The reduction in social interaction has not been sufficiently documented, nor has the increase in morale which the theory predicts should accompany it (Maddox, 1969). Also, there is evidence that low levels of interaction may not be age-linked (Lowenthal, 1964; Maddox, 1963). Although the theory purports to be culture-free, the concept of disengagement is clearly an ethnocentric reflection of North American culture (Rose, 1968) and has not been supported by cross-cultural investigation (Counts and Counts, 1985). The theory also suffers conceptually in that it contains numerous escape clauses, and is therefore unfalsifiable: it is not clear what would constitute negative evidence (Hochshild, 1975). These are but a few of the many criticisms waged against disengagement theory in the 27 years since its introduction. Full assessment of the validity of disengagement theory is beyond the scope of this paper. Suffice it to say that disengagement theory is not generally accepted in social gerontology today, either as a description of, or an explanation for, the social behavior of the elderly.

Despite the many problems with disengagement theory, the fact remains that both scientifically and popularly, there is a very strong tendency to associate old age with social isolation. It is unlikely that early research into old monkey behavior has been free from the influence of this very strong Western perception.

Some authors have specifically mentioned disengagement theory as a possible explanatory framework for the reported decrease in social interaction of aged monkeys (e.g. Hrdy, 1981). Quite apart from the fact that disengagement theory is now widely rejected as an explanatory framework for human social gerontology, there is the fundamental problem of its applicability to nonhuman primates. Social disengagement as described and explained by disengagement theory involves and requires an awareness of death (Chappell, 1975). We have no reason to suspect that nonhuman primates, especially monkeys, possess any kind of an awareness of their own mortality. It is true that monkeys and apes seem to recognize a dead individual as 'gone', and after a brief inspection essentially ignore it. This is, however, very different from having an awareness of one's own limited life. Predictions of, and explanations for, the behavior of aged monkeys based on disengagement theory are, for this reason alone, unsound.

Sociobiological Theory

Sociobiological explanations have been used by some researchers to explain the behavior of aged animals. Assuming the existence of menopause, sociobiologists often suggest that post-reproductive females will behave differently than younger adults in that they will invest in their inclusive rather than their individual fitness. For example, post-reproductive female langurs are said to take greater risks in defence of a grandchild than will the mother (Hrdy, 1981). Hrdy did not present a specific sociobiological explanation for reduced social interaction, but did argue that in general the lower reproductive value of old females is the basis for the evolution of specific behaviors for the aged females, and she discussed withdrawal as an aged female behavior pattern. Hauser and Tyrell (1984) specifically offered an evolutionary explanation for the reported reduction in social interaction. For old females, it was argued, the costs of establishing and maintaining social relationships increase, therefore old females withdraw. The rationale for the suggestion of increased costs is not clear. They offered, as indirect evidence, their own data which indicates the avoidance of social interaction by old females.

The lengthy post-reproductive lifespan of all human females who live out the normal life expectancy, is only one of at least three fundamental distinctions between humans and nonhumans which have a direct bearing on aging phenomena. Menopause, awareness of mortality, and a division of labour are three features of the culture and society of all human groups which render the life course, specifically the latter life course, quite distinct from that of nonhuman primates. No mention is made of these distinctions by researchers of old monkey social behavior although decidedly human theories are used.

Menopause

Attempts have been made in recent years to find evidence of menopause in nonhuman primates. An animal model for such a biologically, psychologically, and socially relevant human condition would certainly be desirable to human investigators and granting agencies. However, upon close examination of the available literature, it is clear that nothing comparable to human female menopause exists in any known nonhuman primate species. Dohlinow (1979), in fact, argued that reproductive success increases with age.

Reproductive senescence in human females is quite distinct from the gradual decline in fertility in very old animals which is often cited as evidence of it. Human females cease to reproduce, indeed to cycle at all, fairly abruptly at approximately 50 years of age. Given that the Maximum life potential for humans is at least 90 years (Cutler, 1976), and that the life expectancy is almost 80 years, this non-reproductive period represents a major proportion of the lifespan. This phenomenon affects *all* women who live out the normal life span. The cessation of reproduction is quite distinct from the gradual biological decline which may occur in other systems, such as the visual or locomotory systems, as a function of advanced age. In fact, this abrupt reproductive system alteration often occurs while the individual is otherwise far from experiencing the biological declines of aging. It occurs in middle age.

What is cited as evidence of menopause in nonhuman primates cannot be distinguished from the general biological decline of the rest of the organism. Cessation of reproduction, when it occurs at all, affects a very small proportion of the adult female population, occurs very late in life, and is highly variable and gradual in occurrence. This is unlike human female menopause. In terms of the social life of these animals, the fact is that the vast majority of nonhuman primate females continue to reproduce until the end of their lifespans.

Awareness of Mortality

As mentioned above, there is, at this point, no reason to suspect that any nonhuman primate, and certainly no monkey, has an awareness of its own mortality. An awareness of mortality requires that an individual have a sense of self, a sense that life is more than oneself. It requires that the individual be an object unto itself. Without this level of conceptualization or abstraction, without the knowledge that one is approaching the end of the lifespan, monkeys could not be assumed to experience aging in any way similar to that of humans. Certainly an awareness of mortality is fundamental to the kind of social disengagement described for humans. Given their high degree of sociability throughout their lives, it is hard to imagine why monkeys should prepare for the ultimate withdrawal of death, when neither the individual nor the society knows it is coming.

Division of Labour and Interindividual Dependency

Fundamental to the body of thought and literature on social gerontology is the concept of dependency. The notion of 'life cycle' reflects the tendency to think of old age as a return to the dependency of early life. Indeed, increasing frailty for the very old does often render them dependent upon others for survival. Economic dependency is another reality of life for many of the aged, in both Western and non-Western cultures, as the individual leaves the work force, or ceases to perform subsistence activities.

This kind of dependence simply does not occur in nonhuman primate society. The question "which animals care for the old ones?" is completely inappropriate. From the point at which a young monkey is weaned, it is completely on its own in terms of subsistence. Monkeys do not share food. Each individual is a complete subsistence unit. There is no division of labour, no specialization of subsistence practices, and no sharing. There is no production and no exchange, and hence no possibility of individuals being dependent for subsistence on others. Monkey society does not carry individuals who are unable to feed themselves, beyond possibly defending a disabled animal from attack by predators or other monkeys. Food is not shared. Goods are not exchanged. Frailty to the point of dependence is not a characteristic of old monkeys because animals in this position would simply die.

The fact of production and exchange in human society has a direct bearing on the position of the elderly, because, as noted above, it leads to life and death interdependence among individuals. Differentials in exchange capabilities have been used to explain the pattern of disengagement or withdrawal which is the subject of this paper. According to exchange theory (Dowd, 1975), the elderly in modern society experience a reduction in resources (for example health, income, energy, material goods, and the ability to perform services), and social withdrawal occurs because of the inability of the elderly to engage in balanced exchange. This argument is offered as an alternative to disengagement theory, but it also attempts to explain social withdrawal. Clearly this rationale for expecting or explaining withdrawal in old monkeys is inappropriate.

For further elaboration of these three distinctions between human and nonhuman primates, see Chapter 6.

Imagine if most women continued to mother, and to give birth, into their seventies, if no one depended in a direct way on anyone else (e.g. no retirement), and if there was no knowledge that one's life would soon, or even eventually, end. How many of the familiar behavior patterns of the aged would we see? What would be the subject matter of social gerontology? Would there be a disengagement theory, or any others, to explain withdrawal? Very likely not.

The social and cultural ramifications of these three features are complex and highly variable across human cultures, but are characteristic of the whole species. Whatever the specific cultural manifestations of aging in human societies, the absence of menopause, the absence of an awareness of death, and the absence of a division of labour with its subsequent interindividual dependence, will certainly render aging in nonhuman primates to be very different from that of humans. Expectations based upon a human bias should therefore be heavily scrutinized.

Hauser and Tyrell (1984) suggested that declining health and energy might be the proximate explanation for the reduction in social interaction which they report. Although the present study did not substantiate the report of reduced sociability, this reference to declining health and energy is an important one. It has been argued here that the human and nonhuman experience in later life may be fundamentally different for at least three reasons. However, while female monkeys continue to reproduce well into old age, probably have no conception of their own mortality, and remain independent, the fact remains that they do age and they do die, and they do so in the context of a complex social group. In humans we know, for example, that reproductive senescence translates into the loss of the active mother role and the loss of the social and cultural meaning attached to the mother role. We know that a decline in visual acuity may result in the inability to drive a car or otherwise get around (loss of mobility, increased dependence), or the inability to read (loss of leisure activity, more spare time). We know that many kinds of social and economic activities are affected by physical frailty. Social withdrawal or disengagement, whether a biased perception or an actual large scale trend, in humans can be traced, directly and indirectly to biological aging within the social and cultural context.

What are the manifestations of biological aging in nonhuman primate society? How does declining health or energy or sensory function translate into individual or social behavior? Further research into the social manifestations of aging in nonhuman primate groups may provide illuminating contrasts and comparisons to aging in the highly cultural human context.

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CHAPTER FIVE
THE ROLE CONCEPT AND OLD FEMALE MONKEYS

INTRODUCTION

The social role(s) of the aged has received much attention from gerontologists attempting to understand aging phenomena. This is not surprising since many role changes are linked to chronological age (McPherson, 1983). For many years the field was dominated by a "role-loss" perspective, whereby aging was seen as a process of role exits (Marshall, 1980), role emptying (Rosow, 1976), and adjustment to a 'roleless' role (Burgess, 1950). It is now understood that aging is a process of role transition, not just role loss; aged individuals transfer to new role sets (George, 1980). Whether the emphasis is on role loss or role transition, the underlying theme is change. The social behavior of elderly individuals is recognized to be significantly different from that of younger adults. While clearly not a homogeneous group, the elderly are nonetheless an identifiable sub-group of society with many characteristic social and behavioral patterns.

Interest in the social phenomenon of aging has extended from humans to the nonhumans primates, and with it have come certain expectations based on the human case. Specifically, the idea that aged monkeys will be distinguishable from younger adults in their social behavior is common. Some researchers have sought to document the behavioral manifestations of old age in monkeys (e.g. Hauser and Tyrell, 1984; Nakamichi 1984), and others make explicit reference to the 'aged role' or the 'role of aged animals' (for example, Maxim, 1979 and Hrdy, 1981) in monkey society. Both the term 'aged role' and the implicit assumption that such a role exists are very common.

The assumption that old animals will exhibit behaviors different than those of younger adults has not been adequately tested. Primatologists have long noted behavioral distinctions between classes of animals and references to, for example, juvenile behavior, or adult male behavior are common. But what of *old female* behavior? Do old females exhibit behavioral patterns which characterize them as an identifiable class of animals? Fedigan (1976) has demonstrated empirically the existence of subgroups of monkeys within a troop who behave in characteristic patterns, however old females were not identified as a distinct subgroup or role.

The objective of this research is to seek empirical evidence for the existence of a behaviorally distinct subgroup: old females. Can variation in behavior be explained as a function of variation in age within the adult female population? The behavior of old females will be compared with that of non-aged adult females to test for statistically significant differences in behavior. This research is also exploratory in that it investigates the complete repertoire of adult female behavior, looking for changes which accompany advancing age. The validity of the assumption that old females constitute a behaviorally distinct subgroup will be assessed, and the behavioral manifestation of aging in a nonhuman primate society will be discussed.

METHODS

The Study Troop

The Arashiyama West troop of Japanese monkeys was selected as the study troop. The 400 member troop is housed in a 58 acre enclosure on a large ranch in South Texas. The area is surrounded by a 10 foot electrified fence. The animals forage on natural vegetation and are provisioned once a day with cattle cubes, grain and occasionally monkey chow. Complete birth, death, and geneological data are available for the troop, and each animal is identifiable. The animals exist with a minimum of human intervention, so the study is based on observations of normal social behavior.

The Subject Animals

A sample of 40 adult females were observed, ranging in age from 5 years old (sexual maturity) to 30 years old (the oldest animal in the troop). A total of 18 females in the troop were 20 years of age or older, and all 18 were included in the sample. The other 22 animals were selected primarily to represent the complete age range from 5 to 19 years, and secondarily, to sample representatively across dominance ranks.

Data Collection

Each subject animal was sampled evenly for time, and a total of 440 hours of focal animal data were collected. The study spanned 20 months in 1986 and 1987, and all seasons are represented. Data were collected throughout the day, except for the heat of summer midday when all activity was a a minimum, and except for the 2 hours immediately following provisioning.

Data Analysis

The chronological age of each subject was treated as the independent variable in this analysis. The dependent variable is behavior. However, behavior is continuous, so for the purpose of measurement, the flow of behavior was broken down into meaningful behavioral units. The list of behavioral units identified and measured (the ethogram) contains two types of behaviors: those which are ongoing and require time, and those which are instantaneous, requiring no prolonged time. The former, designated as 'states', are behaviors such as foraging and sleeping. The measurement here is the duration of time spent in the activity. The latter, designated as 'events' are behaviors such as threatening another animal or making a vocalization. Here, the measurement is the frequency of occurrence. The two categories for the dependent variable therefore are 'event' behaviors, for which an animal has a total frequency score, and 'state' behaviors, for which an animal has a total duration score. These frequency and duration scores for a wide variety of possible behaviors are treated as the dependent variables. Table 5.1 presents a complete list of the dependent variables.

Table 5.1
TABLE OF DEPENDENT VARIABLES

Events Scored for Frequency	States Scored for Duration
Approach(direct or receive)	Forage
Leave(direct or receive)	Sit
Groom solicitation(direct or receive)	Follow(direct or receive)
Chase(direct or receive)	Locomote
Bite(direct or receive)	Drink
Defensive scream(direct or receive)	Groom(direct or receive)
Threat (direct or receive)	Sit in body contact (direct or receive)
Displace(direct or receive)	Self groom
Food call	swim
Lunge(direct/receive)	Sleeping/dozing
Contact call	Courtship stage 1
Warble/Girney voc.(direct/receive)	Courtship stage 2
Stare(direct/receive)	Courtship stage 3
Fear grimace(direct/receive)	Courtship stage 4
Seek aid (direct/receive)	TOTAL TIME IN SOCIAL INTERACTION
Support (direct/receive)	TOTAL TIME IN NON-SOCIAL ACTIVITY
AFFILIATIVE BEHAVIOUR (DIRECT/RECEIVE)	SOCIAL BEHAVIOUR DIRECTED
AGONISTIC BEHAVIOUR (DIRECT/RECEIVE)	SOCIAL BEHAVIOUR RECEIVED

For the purposes of the analysis, certain higher level classes of behavior were heuristically constructed from the original ethogram units. For example, the agonistic behaviors (threat, chase, bite, etc.) were grouped together into a behavioral class called agonistic behavior (for discussions of describing and measuring behaviour, see Reynolds, 1976 or Asquith, 1984). Sexual behavior was recorded at the level of behavioral categories based on Stephenson's (1974) designation of four stages of courtship behavior.

The stages of courtship behavior are as follows:

Stage one: advertising and monitoring
Stage two: attempting to gain proximity to other
Stage three: attempting to start a mount sequence
Stage four: attempting to maintain a mount sequence

These higher level categories were tested in addition to the ethogram units. The behavioral classes are included in Table 5.1, and appear in upper case letters.

The unit of analysis is the individual animal, and the total number of cases is 40. A Pearson product moment Correlation was used to detect a relationship between the 40 age scores, and the 40 scores for each of the 55 dependent variables. The general null hypothesis is: there is no significant correlation, positive or negative, between age and the frequency or duration of any behavior.

A second stage of analysis involved breaking the sample down into three age groups: young (5 – 10 years), middle (11 – 19 years), and old (20+ years). For each of the 55 behavioral variables, these three age categories were compared for significant differences. Where the assumptions of parametric testing could be met, a oneway Analysis of Variance was used; where they could not, the nonparametric Kruskal-Wallis analysis of variance of ranks was used. This age breakdown allowed for the investigation of the nature and direction of behavioral change across the lifespan.

RESULTS

Table 5.2 shows the results of the Pearson's Correlations of age by all behaviors. Tables 5.3 and 5.4 show the results of the age breakdowns for these same behaviors. The behaviors appearing in Table 5.3 are those which met the conditions of the oneway Analysis of Variance test, including the assumption of homogeneity of variance. Those which could not meet this condition were tested using the non-parametric Kruskal-Wallis analysis of variance of ranks. These results are presented in Table 5.4.

A significant positive correlation was found between the age of the animal and the amount of time it spends sleeping or napping during the day. Both Hauser and Tyrell (1984) and Nakamichi (1984) also reported increased periods of rest time for the aged animals. This may be an indication that a reduction in energy levels is occurring as part of a general biological decline, however, it is not known whether aged animals sleep less during the night, as has been reported for aged humans. In any event, the r value, indicating the strength of this relationship is only 0.39, a moderate correlation. This result is confirmed by the Analysis of Variance of the three age groups (see Table 5.3). It is clear that the difference lies with the old females (X=110.68) and is not a gradual change showing up in the middle age group as well (middle X=79.13, young X=81.69). The p value for this result is 0.07.

The strong negative correlation between age and the amount of time spent advertising and monitoring supports an earlier finding (McDonald, 1985) that this stage of the courtship process is characteristic of very young sexually mature

Table 5.2
Results of Pearson Correlations
Age and Behavior

BEHAVIOUR	r value	p value
Events		
Approach (d)	-0.67	0.00
Approach (r)	.00	0.98
Leave (d)	-0.39	0.01
Leave (r)	-0.35	0.03
Groom solicitation (d)	-0.29	0.07
Groom solicitation (r)	0.11	0.47
Chase (d)	-0.16	0.31
Chase (r)	-0.23	0.16
Bite (d)	-0.13	0.41
Bite (r)	0.37	0.02
Defensive scream (d)	0.06	0.71
Defensive scream (r)	0.11	0.49
Threat (d)	0.00	0.95
Threat (r)	-0.15	0.35
Displace (d)	-0.10	0.53
Displace (r)	0.04	0.80
Lunge (d)	0,05	0.75
Lunge (r)	-0.17	0.29
Contact call	0.36	0.02

BEHAVIOUR	r value	p value
Warble (d)	-0.26	0.11
Warble (r)	0.02	0.88
Stare (d)	0.13	0.44
Stare (r)	-0.14	0.39
Fear grimace (d)	-0.26	0.10
Fear grimace (r)	-0.09	0.56
Seek aid (d)	0.12	0.46
Seek aid (r)	0.13	0.41
Support (d)	0.19	0.25
Support (r)	0.12	0.47
Affiliative beh.(d)	-0.64	0.00
Affiliative beh.(r)	.0.02	0.92
Agonistic beh.(d)	0.04	0.79
Agonistic beh.(r)	-0.11	0.51
States		
Forage	-0.02	0.92
Sit	-0.18	0.26
Follow (d)	0.04	0.83
Follow (r)	-0.05	0.77
Locomote	0.28	0.08
Drink	-0.04	0.83
Groom (d)	-0.12	0.46

BEHAVIOUR	r value	p value
Groom (r)	0.06	0.72
Sit beside (d)	-0.30	0.06
Sit beside (r)	0.20	0.21
Self groom	0.01	0.97
Sleep/doze	0.39	0.01
Courtship 1	-0.63	0.00
Courtship 2	-0.12	0.45
Courtship 3	-0.18	0.27
Courtship 4	0.08	0.64
Social time	-0.12	0.48
Social beh.(d)	-0.25	0.12
Social beh.(r)	0.19	0.24

females. In the present context, this result probably has little to do with old age, but rather is a reflection of a behavior pattern which changes as very young adult females gain experience in mating activity. This is supported by the average rank scores of the three age groups on the Kruskal-Wallis test, where it is clearly the young animals with the distinctly high score for courtship stage one.

There is a fairly strong negative correlation between age and the frequency of approaching others and directing affiliative signals. It is important to make clear that the frequency of approaching others is the major behavioral unit in the affiliative behavior class, and these are not therefore to be considered independent

Table 5.3
Analysis of Variance
3 Age Categories by Behavior

Behavior	Grand Mean N=40	Old Mean N=18	Middle Mean N=12	Young Mean N=10	F value	p value
Durations						
Forage	54.16	50.33	63.87	49.41	1.32	0.29
Sit	90.43	82.58	94.94	99.13	1.06	0.36
Drink	1.47	1.60	0.89	1.94	2.39	0.11
Groom(r)	79.86	81.91	77.08	79.51	0.12	0.89
Sit Beside(d)	41.02	35.04	39.42	53.71	1.09	0.35
Sit Beside(r)	43.48	49.16	36.43	41.73	0.75	0.48
Self Groom	22.59	23.58	21.05	22.66	0.12	0.88
Sleep/doze	93.97	110.68	79.13	81.69	2.74	0.07
Courtship 2	13.23	11.67	13.99	15.16	0.15	0.86
Courtship 4	3.43	3.94	5.52	0	1.75	0.19
Receiving Social Beh.	123.34	131.07	113.51	121.23	0.77	0.47
Directing Social Beh.	152.17	139.57	161.31	163.90	0.69	0.51
Frequencies						
Approach(d)	11.35	8.22	11.58	16.70	8.69	0.00
Approach(r)	16.90	16.94	17.17	16.50	0.03	0.97
Leave(d)	13.15	11.16	13.67	16.10	3.06	0.06
Leave(r)	13.43	12.28	13.67	15.20	1.00	0.38

Behavior	Grand Mean N=40	Old Mean N=18	Middle Mean N=12	Young Mean N=10	F value	p value
Groom solicitation(r)	4.23	4.56	3.92	4.0	0.25	0.78
Bite(d)	0.20	0.22	0.83	0.30	0.62	0.54
Defensive scream(d)	0.77	0.83	0.50	1.0	0.99	0.38
Threat(d)	3.25	3.17	3.75	2.80	0.36	0.70
Lunge(r)	0.48	0.44	0.50	0.50	0.04	0.96
Warble(d)	3.23	2.67	3.67	3.70	0.91	0.41
Fear grimace(r)	0.15	0.11	0.17	0.20	0.11	0.89
Support(r)	0.20	.022	0.25	0.10	0.41	0.67
Affiliative Beh. (d)	19.93	15.33	19.83	28.30	9.72	0.00
Affiliative Beh. (r)	23.35	23.67	23.17	23.00	0.03	0.98
Agonistic Beh. (d)	6.30	6.50	6.42	5.80	0.07	0.93
Agonistic Beh. (r)	3.95	4.00	3.42	4.50	0.34	0.71

results. Nonetheless, it is clear that old females approach others less than do younger females. This reduction in approach behavior is not accompanied by any reduction in the total amount of time spent in social interaction (sitting beside or grooming), and there is no indication that old females receive more approaches, so this result is curious. Possibly the pattern suggests that old females are more

Table 5.4
Kruskal-Wallis
analysis of variance by ranks
3 Age Categories by Behavior

Behavior	Average Rank Score			Statistic	p value
	Old N=18	Middle N=12	Young N=10		
Durations					
Locomote	22.22	22.33	15.20	2.74	0.25
Follow(d)	17.83	23.21	22.05	1.76	0.42
Follow(r)	21.58	20.50	18.55	0.43	0.81
Groom(d)	19.69	21.42	20.85	0.17	0.92
Courtship 1	15.0	20.58	30.30	11.01	0.00
Courtship 3	19.44	24.08	18.10	1.69	0.42
Frequencies					
Groom solicitation(d)	18.58	15.96	29.40	8.09	0.02
Chase(d)	18.11	23.67	21.00	1.65	0.44
Bite(r)	23.06	19.17	17.50	1.67	0.43
Defensive scream(r)	21.08	22.96	16.50	1.75	0.42
Threat(r)	21.53	17.92	21.75	0.84	0.66
Displace(d)	19.22	21.42	21.70	0.39	0.82
Displace(r)	20.28	20.33	21.10	0.04	0.98
Lunge(d)	20.28	23.08	17.80	1.13	0.57
Contact call	25.22	20.96	11.45	8.94	0.01

Behavior	Average Rank Score			Statistic	p value
	Old N=18	Middle N=12	Young N=10		
Warble(r)	22.44	21.33	16.00	2.04	0.36
Stare(d)	20.64	21.13	19.50	0.11	0.95
Stare(r)	19.11	23.00	20.00	0.82	0.66
Fear grimace(d)	17.56	22.29	23.65	2.15	0.34
Seek aid(d)	21.17	18.33	21.90	0.61	0.74
Seek aid(r)	21.11	20.00	20.00	0.89	0.96
Support(d)	21.50	19.25	20.20	0.27	0.87

stable once in an interaction. In other words, they may move around between partners less. This suggestion is supported by the fact that older females leave others ($r=-0.39$, $p=0.01$) and are left by others ($r=-0.35$, $p=0.03$) significantly less than younger females. From the group means presented in Table 5.3, it appears that these patterns represent a fairly steady change across the life course. The weak positive correlation between contact calling and age ($r=0.36$, $p=0.02$) may be an indication that overall affiliative desire does not decrease, since contact calling generally indicates a desire for affiliation or social contact. The Kruskal-Wallis test indicates that there is a significant difference and the low scores of the young are responsible (old=25.22, middle=20.96, and young=11.45, $p=0.01$)

Another possible interpretation, supported by the results of the ANOVA, is that these results are a function of youth rather than of old age, since the group means show a decline from the young to the old age groups, with the largest difference, for both approaches and affiliative behavior in general, showing between the middle and the young groups. Young females may be less experienced and less stable in their interaction patterns, and are more energetic and mobile. This might explain young adults approaching and leaving others more. This behavior varies uniformly across the age groups, with the old females being left the least (old=11.16, middle=13.67, young=16.10, p=0.06). Young females may be left by others more due to inexperience or inefficiency in grooming activity. This would parallel what has been reported for variation in courtship patterns.

A moderate negative correlation (r=−0.30, p=0.06) occurs between sitting in body contact with another and age. The analysis of variance of this behavior was not significant, however the means presented in the ANOVA table indicate that it is the young who are responsible for the high scores (old=35.04, middle=39.42, young=53.71)

A high frequency of groom solicitations, a strongly affiliative behavior, weakly correlates with low age scores (r=−0.29, p=0.07). When the frequency of this behavior is compared across the three age groups, there is a significant difference between the middle and the young groups (old=18.58, middle=15.96, young=29.40, p=0.02).

There is a weak trend (r=0.28, p=0.08) toward young females locomoting less than old females. The Kruskal-Wallis ranks indicate that the old and middle females are very similar in locomotion scores, and it is the young with the lowest scores (old=22.22, middle=22.33, young=15.20). This difference is not significant. If we equate locomotion with mobility, then this result is surprising, because young females would be expected to be more mobile than the old females.

The results presented in Table 5.2 indicate a positive correlation between age and the frequency of receiving bites from other animals ($r=0.37$, $p=0.02$). However, this is a very rare behavior, as is evident from the extremely low group means in Table 5.3. The results of the ANOVA do not support the suggestion that receiving bites increases with age.

Certain age-related behavioral variations were absent in these data, variations which might have been expected given results reported elsewhere, Nakamichi (1984) reported a significant negative correlation between self grooming and age, and that younger females groomed others more frequently that they were groomed. The reverse pattern occurred for older females. These patterns did not occur in the present study. Hauser and Tyrell (1984) reported that old females locomote less than young females, the reverse of the pattern found here.

Out of a total of 55 dependent behavioral variables, only seven showed a significant correlation with age, and two of these are largely the same variable. Furthermore, the significant correlations are only moderate in strength. Overall then, it appears from this analysis that age has little explanatory value for behavioral variation within the sample of adult females, and there is little evidence that old females behave differently from adult females in general.

DISCUSSION

The expectation that old age in a monkey society will be evident by some kind of subgroup differentiation is prevalent. This study however was unable to document much behavioral variation within the adult females which is based on age. Where age-related variation occurs, it is better explained as a function of youth rather than a function of old age.

There is a tendency for increasing age to correlate with an increased tendency to sleep or nap during the day. This may be an example of a behavioral manifestation of biological aging. However, beyond this, there are few behavioral manifestations of approaching the end of the lifespan.

The expectation that old age will bring with it behavioral manifestations is prevalent. In other words, biological aging is expected to translate into social aging. But what will the relationship between biological and social aging actually be in a nonhuman primate society?

It is important to first consider the different types of aging in human society. Biological aging refers to the inevitable changes in the organism which occur with the passage of time, and culminate in senescence of biological systems, and eventually in the death of the individual. Biological aging is often thought of as the causal factor in other types of aging. Psychological aging involves changes in, for example, personality, perspective, sense of self, world view, emotional state, cognitive function, and motivation. These are often the result of changes in the biological organism, or the result of the interpretation of changes in the biological organism. Social aging refers to the changing position of the individual in the social structure, as a result of biological and psychological aging, and the social meaning which is attached to it. Although highly variable across cultures, the elderly do represent a group with age-specific social patterns within a social system.

According to this view, the changes would seem to occur within the biological organism as time passes, and this translates to psychological and social changes. However, the directionality is not, in fact, just one way. Being designated as 'old' by society (for example, over 65 = senior, forced retirement etc.) can lead to psychological changes (for example, lower self esteem, boredom, depression) and this can lead to physical changes (for example, lethargy, poor health) which may actually affect biological age. But ultimately, if biological aging did not occur, it is safe to assume that related psychological and social changes would not take place.

In human society, then, many cultural factors come in to play in the translation of biological to social aging. The changes which occur in the physical organism as the result of the passage of time directly affect individual and social behavior patterns, and have an even more profound effect in that they are the focus of conscious attention. For example, declining visual acuity or a reduction in response time may result in an individual being no longer able to perform functions which characterize earlier individual behavior patterns (for example, recreation and leisure, mobility) and patterns which defined the individual in terms of the social group (for example, employment or subsistence activities). Social and cultural institutions both reflect and reinforce the changing behavior and position of the aging individual. These changes have meaning for human individuals in that they signal the approach of the end of the lifespan. This requires, of course, the capacity for abstract thought and awareness of mortality, at least. Human cultural and technological complexities make it possible and likely that biological changes in the individual will translate into patterns of psychological and social aging, which are reinforced by the society.

In monkey society, many of the factors which would facilitate the translation of biological into social aging are absent. Monkeys are not aware of mortality, they do not cease to reproduce at any certain age, and they do not depend on one another in any direct way (see Chapters 4 and 7, this volume). Many of the complex interplays between the biological organism, the psychological individual, and the society, are absent. For example, old monkeys continue to care for themselves, in terms of subsistence, until death. Important normative effects are absent, such as the effect of being labelled 'old' by society. Being characterized as old often makes people behave in an old manner. This does not happen in nonhuman primate society.

Some authors have argued that behavioral changes are more than just the result of increasing biological senescence in old monkeys, and that in fact, natural selection has favored the evolution of a specific set of behaviors for aged animals. The basis for this line of reasoning is the pleiotrophy theory of aging described by Williams (1957). According to this theory, genes which have detrimental effects on the organism in later life may still be favored by natural selection because they have a beneficial effect early in life, and would be passed on in these early reproductive years. Hence, aging occurs, and reproductive value declines with advancing age, as the pleiotrophic genes begin to manifest their effect. So, reproductive decline with age is established in this theory. Evolutionists investigating aged behaviour accept this. Then, based on the assumption that aged individuals no longer reproduce themselves (individual fitness), they therefore become the target of the forces of kin selection (inclusive fitness). Thus, there exists "selective pressure favoring the development of special behavior patterns in old animals" (Hrdy, 1981:70).

Reproductive senescence is perhaps the essential element in this line of argument, and there is little evidence, especially in Japanese monkeys, that a post-reproductive lifespan exists. The data presented in this report indicate a concomitant absence of special behavior patterns. Hrdy cites as evidence of her position, Partch's (1978) report that "post reproductive females defended infants in their own family lines in preference to infants of other lines" (Hrdy, 1981:64). Regardless of whether or not these females were post-reproductive, it has been widely reported in the primatological literature that female macaques defend kin in agonistic encounters with non-kin, and this is not an age-related pattern.

Role theory in social gerontology focuses upon role-loss and role transformation, and indeed, many social and cultural changes are associated with entering the latter portion of the lifespan in human society. Aged human females face quantitative and qualitative changes in many areas of their lives. Parents become grandparents, wives become widows, employees become retirees, and healthy become frail – or more importantly, independents become dependents. Certainly these statements are simplifications, and it is recognized that old humans are far from a homogeneous group. Nonetheless, growing old in human society has recognizable (albeit variable) behavioral and social concomitants, many of which are addressed in role theory.

What role loss or role transition might be expected for aging female monkeys? The transition from mother to grandmother would be fundamentally different in monkeys since the change would be additive and not transitory. Old female monkeys are themselves still mothers, so the parental status of their adult daughters would have much less impact on them. The role of mother is not lost in old age. Japanese macaque females continue to give birth well into old age, generally until a year before death (Fedigan, 1987).

The role of alpha female or of subordinate female would not be expected to change with old age, since dominance rank is not a function of physical prowess, but of lineage membership, social skills, and lifetime alliances. If anything, role characteristics based on dominance rank would be expected to solidify and strengthen with advancing age.

Japanese monkeys do not 'mate for life', so nothing comparable to widowhood occurs. There is no division of labor, and every animal entirely feeds itself, so nothing comparable to retirement occurs. For the same reason, the existence of an old animal in a 'dependent' role is without basis.

The application of the role concept to nonhumans is problematic for a number of reasons. Role theory involves role cognition, role awareness, role expectations and role norms. Reynolds points out the critical distinction that in humans, "roles are 'in mind', whereas in animals (one assumes) they are not" (1970:449). He goes on however to argue that there is a usage of the role concept, which, if clearly defined, and distinguished from the strictly human usage, can be a useful tool in the primatological context. He defines monkey roles as "statistically probable behaviors in a given interactional and ecological setting"(1970:450). An example would be the role of 'control animal' as described by Bernstein (1966).

Considering then a role concept which refers only to observable behavioral characteristics of subgroups of animals within a society, a role concept which is appropriate for application to nonhuman primates, I return to the notion of an old monkey or old female monkey role. Would a role distinction in monkeys be expected for members of one end of a single continuous variable? Can role be reduced to a single variable such as age? Gartlan (1968) in his classic essay on "Structure and Function in Primate Society" attacks the reduction of primate society and primate social relationships to dominance rank and dominance hierarchies. Fedigan (1976:2) states that "rank alone is not a sufficient explanation for social organization ... or ... individual behavior" and proposes multivariate criteria for role categorization. Similarly, role cannot be delineated by the single variable *age* – and the notion of old animals having a social role or exhibiting subgroup behavior simply because of their age is faulty. Growing old as a human has many social concomitants that simply do not exist in animal society.

Also central to the role concept as applied to monkeys is function. Implicit in role conceptualization is the notion of 'adaptive differentiation of function between group members" (Gartlan, 1968). Any identified social role can or should be seen as functioning in some adaptive way for the individuals in the group. According to Benedict, "role playing limits competition and promotes ... peaceable coexistence"(1969:207). What would be the function of role playing in old female monkeys? In what way would they function differently from other adult females? Possibly in a situation of scarcity in the wild, older animals would know where to find food or water outside of the groups current home range. It is conceivable that this kind of leadership function may occur in rare instances, but it is not the basis for the existence of a regular subgroup with distinctive behavior patterns. It has already been pointed out that old monkeys continue to be mothers, so the sociobiological hypothesis that old animals should invest in their inclusive rather than their individual fitness is unsound.

In this paper, the idea that old monkeys constitute a distinct sub-group or occupy a social role because of their advanced age is assessed on both empirical and theoretical grounds. There is little evidence that the behavior of the aged females differs significantly from that of the other adult females, and it does not appear that the fact of biological aging creates any radically different social situations which would cue the onset of specific role behavior for aged animals.

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CHAPTER SIX
AN EXPLORATION INTO THE SOCIAL NETWORK OF OLD FEMALE JAPANESE MONKEYS

INTRODUCTION

With the recent surge of interest in aging in human society has come an interest in aging in nonhuman primate society, where highly intelligent and highly social animals live relatively long lives in complex social groups. Primatologists and social gerontologists now realize that much is to be gained by having a broader primate perspective on aging in a social group.

Field research into the behavior of aged animals is very limited, due in large part to the fact of poor accessibility to animals and information: large samples of wild animals of known age are very rare. Japanese macaques currently represent the best species for this area of investigation, due to the Japanese tradition of longitudinal research on provisioned and wild groups. Nakamichi (1984) reported on the behavior of aged female Japanese monkeys at Arashiyama in Japan, and Hauser and Tyrell (1984) on the behavior of female Japanese monkeys at the sister troop, Arashiyama West, in Texas. These authors report, among other things, that old females experience social disengagement – interacting less with the social group than do young females. This is important, since changes in an individual's social network and general sociability are fundamental concepts in our current understanding of the phenomenon of aging.

It is argued in this thesis that previous research into the behavior of aged monkeys has suffered from methodological and conceptual shortcomings, and the objective of this study has been to provide a comprehensive investigation into old females, with a research design which avoids the previous methodological problems. The two previous chapters have discussed aging changes from two different perspectives: chapter four considered the general relationship between an animal's age and her degree of sociability – the size of her social network and the amount of time spent in activity with members of this social network. Chapter five considered the possibility of changes in the individual behavior of old females. Another possible change which might occur in old age is in the characteristics of the social network, and this chapter presents the results of an exploration into this possibility.

Along with the persistent notion that old humans experience a reduction in the size of their social network in old age, are reports of more specific social network changes. For example, old people are said to rely more on family than non-family (McPherson, 1983), and to exhibit age homophyly – the tendency to interact with age mates rather than with younger adults (Hess, 1972). It is possible that age changes in monkeys will manifest themselves in some way other than individual behavior or overall social network size. The identity of the others with whom the aged individual spends time may also be important and needs to be explored. This study addresses qualitatively and quantitatively the relationship between age and characteristics of the animal's social network.

METHODS

The Study Troop

The study troop, a semi-free ranging troop of Japanese monkeys, is located on a large ranch near the town of Dilley in south Texas. Dilley is halfway between San Antonio and Laredo, and an area that is predominantly scrub-brush.

The animals, numbering close to 400, live in a 58 acre area enclosed by an 8 foot electrified fence. All animals are identifiable by a facial and leg tattoo. They are provisioned daily with cattle cubes and grain, and also forage on natural flora.

Observations on the troop began in 1954 in Japan, and the troop was transplanted to Texas in 1972. Complete birth, death, and geneological records continue to be maintained on a daily basis. The animals exist with a minimum of human intervention, and are habituated to the presence of at least one behavioral researcher.

The Subject Animals

The subject group consisted of 40 females, ranging in age from 5 to 30 years old. Since Japanese macaques have a Maximum Life Potential (Cutler, 1976) of approximately 30 years, those 20 years and older were deemed to be in the third trimester of their lifespan. Eighteen females in the troop were 20 years of age or older, and all of these animals were included as subjects. These 18 animals therefore constituted the aged animals. A comparative group of 22 animals ranging in age from 5 to 19 years was also sampled. At least one animal from each birth cohort was included, and beyond this sampling for age, an attempt was made to sample evenly for dominance rank.

Data Collection

Each subject animal was sampled evenly for time, and a total of 440 hours of focal animal data (Altmann, 1974). were collected. The study spanned 20 months, during 1986 and 1987, and all annual seasons are represented. Data were collected throughout the day, except for the heat of summer midday when all activity was at a minimum, and except for the two hours immediately following provisioning.

Data Analysis

The goal of the analysis was to examine the data for indications that characteristics of an animal's social network change with advancing age. Constructing a list of the social network of each subject was the first step. Second, these data were described and explored qualitatively. Third, a number of characteristics of the social network were identified, and for each characteristic and each subject female, a score was calculated. Finally, quantitative methods were used to test for statistically significant relationships between age and the various social network scores. Each of these four steps in the analysis will be discussed in greater detail.

The Social Network Data.

From the focal animal data a list was constructed of each subject and each other animal with whom the subject had spent time in social contact. This was essentially a list of the social network of each of the 40 subject animals. Information about the other animal, and about the relationship between the two individuals in each dyad was added to this list. These were the age and the dominance rank of the other animal, the degree of genetic relatedness between the pair, and the total amount of time the two spent together. This last score, social contact time, was also calculated as a percentage and a proportion of the total time which the focal animal spent in social contact.

The number of years since birth was used as the measure of the age of the individuals in the subject's social network. The assignment of a dominance rank score was based upon membership in a particular lineage. The lineage rankings were provided by management at the research center. Lineages with branches of clearly different dominance were broken down accordingly and assigned the most meaningful dominance rating. The rating scale ranged from 1, the lowest rank, to 22, the highest rank.

A kinship score was assigned to each dyad in order to test for the possibility that kin become more or less important to the individual as she ages. The kinship score was a measure of the probable proportion of shared genetic material between the two individuals: a coefficient of relationship. The scores can run from 1.0 (identical twins) to 0.0 (non-relatives). In human society, where paternity is generally known, parents and siblings are considered first degree relatives, and are both assigned a 0.50 degree of relationship with ego. In this analysis, because paternity is not known, and siblings are very likely to be only half siblings, siblings are assigned 0.25 coefficient of relationship, and only the mother-offspring dyad is assigned the full first degree score of 0.50. Following the suggestion of Kurland and Gaulin (1979), all relationships which extend from the sibling step in the pedigree are likewise affected. The dyads which exist in this body of data and their coefficients of relationship are as follows:

Mother-daughter	0.50
Siblings	0.25
Grandmother-granddaughter	0.25
Aunt-Niece	0.125
Cousin	0.0625
1 1/2 Cousin	0.03125
Great Aunt-Niece	0.03125
Second Cousin	0.0156

The fourth variable added to the social network data was a measure of the strength of the relationship based upon the amount of time which the two animals spent together. A raw score, in seconds, was entered, as was a conversion of this score to both a percentage and a proportion. From these percentage scores it was possible to easily rank the interacting animals in each social network from highest to lowest, in terms of the percentage of the focal animal's total social contact time. The importance of each relationship, to the focal, was inferred from this ranking.

Descriptive Data

Each of the focal animals had between 2 and 13 others with whom she was observed to spend time. While it would be impossible to present all of the social network data here, it is interesting to consider at least the first two cases for each focal animal. Table 6.1 is a presentation of the identity of the first and second partner, the percent of the social contact time for which they are responsible, and the age and the total network size, for each subject female. The purpose of this table is to enable the reader to look at the data, and to note the variation in the percent scores of the first and second partner, and the variation in the identity of the partners, across the sample of subject females. Tables 6.2 and 6.3 summarize these data and present comparisons across the age groups,. Within the sample of 40 animals, there occurred 16 mother offspring pairs. The social network data file made it possible to compare, for each dyad, the relative importance (as measured by time spent together) of the mother to the daughter, and the daughter to the mother. Since all dyads contained mothers who were aged, or very close to aged, the variation in the importance of the relationship could prove to be informative. Table 6.4 presents this comparative information.

Calculation of the Network Characteristic Scores for each Female

The purpose of this section of the analysis was to obtain scores which accurately reflect the overall nature of the social network of each female. For example, it was important to determine an overall dominance rank of the others with whom the subject spent time. Did the subject interact with high or low ranking animals? Did the subject interact with old or young animals? With kin or non-kin? For each of these three variables (age, rank, and kinship), a generalized score for the network was obtained. Since all others were clearly not equally important to the focal, these were calculated as weighted means. The weighting was based on the amount of "time spent" with the focal animal, using the proportion conversion of time spent score. A weighted mean dominance rank score for the social network of a particular animal was obtained by summing the products of the proportion contact and the dominance rank of the other, for each subject. In other words, for each dyad, the proportion of contact between the two animals was multiplied by the rank score for the interacting animal, and these were summed over each of the focal animals. This same procedure was used to determine the age and degree of kinship in the social network of each focal animal.

These first three variables, calculated for each focal animal were: rank of the network; age of the network; and degree of kinship in the network. For each of these three, two other variables were also calculated: the variance, and the coefficient of relative variation. These scores enabled me to test for the possibility that, for instance, fewer other age groups are interacted with in old age, or fewer other rank groups. Basically this measures the homogeneity of the network, in terms of age, rank, and kinship. The variance was also weighted according to the strength of the dyad, and was therefore calculated by subtracting, from each rank score, the mean rank score, squaring this value, multiplying it by the proportion of contact score, and summing these values for each focal female.

The coefficient of variation, calculated as the variance divided by the mean, expresses the variance as a percentage of the mean. Since the coefficient of variation is a measure of relative variation expressed as a percent, the coefficient of variation can be used to compare the variability of two or more sets of data when the observations are expressed in different units of measurement. In this analysis, the relative variation was computed by dividing the weighted variance by the weighted mean.

Another interesting question has to do with the pattern of contact displayed by the animal. As is evident from Table 6.1, there was a great deal of variation in the number of others, as well as in the distribution of time spent: some animals spent as much as 90 percent of their social contact time with one other, some animals distributed their social contact time much more evenly. The question here is whether aged animals show a change from younger animals in this pattern. Do they have many casual relationships or few strong ones? In Table 6.1 the reader can assess this possibility by looking at the age, network size and the strength of the first two partners. In order to test this statistically, three scores were calculated which reflect this kind of patterning. In these calculations, the raw social contact scores were used. First, the average amount of time which the focal spent with any other was calculated by summing the raw contact scores and dividing by the number of scores. Then the variance and relative variation in social contact scores were calculated. Variance was calculated by summing the squares of the difference between each contact score and the mean contact score (as calculated above), and dividing this number by the total number of others minus one. Relative variation was determined by dividing the mean contact into the variance in contact. This measures the inequality in contact time.

This section of the analysis resulted in values for each subject female on 12 new variables which reflect various characteristics of the social network of each animal. These variables were then tested for the possibility of age related variation.

Statistical Tests

The purpose of this analysis was to determine if any changes occurred as an animal ages, with respect to the identity of the others with whom they interacted and their pattern of interaction.

First, a distribution of each of the 13 network variables was drawn to check for univariate outliers. Next, a scattergram of age with each of the 12 variables was constructed to check for bivariate outliers, and to provide visual evidence of any relationship with age. A Pearson product moment correlation was then used to mathematically assess the relationship between the age scores, and each of the 12 network variable scores. This test could also be used to determine how much of the variation in a particular network variable could be explained by variation in age.

The Pearson product-moment correlation tests only for a linear relationship between the two sets of scores. Because of the possibility that an increase or decrease in network scores could be associated with middle age, rather than youth or old age, the subjects were grouped into three age groups (young, 5–10 years; middle, 11–19 years; and old, 20+ years). These three age groups were compared for significant differences in the social network scores. A oneway Analysis of Variance test was used in all cases where the assumptions of this parametric test were met. In two cases, the condition of equality of variances could not be met, so for these cases, the Kruskal-Wallis test was used. Table 6.6 includes the variables which could not be tested by the ANOVA, in order to present the means for each age group, plus the total sample. All variables are also presented in Table 6.7, because all can legitimately be tested using the non-parametric test.

RESULTS

Variability is prevalent both within and between individuals in terms of their social networks. Networks vary in size (2 -- 13) and in the distribution of time spent with others. The identity of the members of the network also varied greatly. Table 6.1 presents the complete sample of females (N=40), their ages, the size of their social network, and the identity of, and percentage of time spent with, the first two social network members. The statistical tests, below, were used to test measures which characterized the network based on all members. But it is also useful to look individually at the first two, the two strongest relationships. In Table 6.1, the subject animals are arranged in descending order of age. It has been established that there is no significant difference in the size of the social network, based on age (see Chapter 2, this volume). It is evident from scanning column three that the network size scores show no clear increase or reduction with age.

Column 5 demonstrates that there is a great deal of variation, among animals, in the strength of their primary relationship. One individual, #361, spent 99 percent of her social contact time with one other animal — her mother. Other animals, like #125, had a primary relationship which was comparatively weak: only 25 percent of her total social contact.

Table 6.2 summarizes the data on the identity and strength of the strongest relationship, or primary partner. This information is provided for the total sample as well as for the three age groups. It is thus possible to compare, across the age groups and to the total sample, the frequency of a particular class of animal, for example, mother.

In the total sample, the most common primary partner was the mother or daughter. This shows a clear age breakdown: old females have a very strong tendency for their primary partner to be a daughter: young females have a very

Table 6.1
LIST OF ALL SUBJECTS WITH IDENTITY AND STRENGTH OF 2 STRONGEST INTERACTANTS

I.D.	AGE	SOCIAL NETWORK SIZE	PRIMARY PARTNER	% OF TIME SPENT WITH	SECOND PARTNER	% OF TIME SPENT WITH
39	30	10	Son	56	UAM	16
99	26	7	Dau	82	UAF	7
38	25	11	Dau	39	Si	22
86	24	9	Dau	25	Dau	24
92	23	12	Son	30	UAF	18
36	23	6	Gda	56	UAM	23
32	22	11	Dau	42	UAF	12
6	22	7	UAF	59	UAF	15
77	22	8	Dau	33	Dau	20
90	22	2	Dau	87	UAF	13
97	22	7	Dau	64	Dau	14
40	21	9	UAF	39	Dau	20
11	21	8	Dau	44	UAF	15
85	21	11	Dau	32	Dau	24
133	21	10	Dau	36	Si	18
49	20	8	Dau	30	Dau	29
26	20	3	Dau	91	UAF	8
117	20	11	Dau	42	Si	23
58	19	7	Bro	52	Dau	17
60	18	9	Dau	67	UAF	12

I.D.	AGE	SOCIAL NETWORK SIZE	PRIMARY PARTNER	% OF TIME SPENT WITH	SECOND PARTNER	% OF TIME SPENT WITH
142	18	8	UAM	40	Dau	32
5	17	12	Mo	47	UAM	16
52	17	7	Mo	77	Cou	8
157	16	8	Mo	38	Dau	23
114	15	7	Mo	58	Cou	10
161	14	11	Dau	29	UAM	19
8	14	9	Mo	70	UAM	15
111	12	8	UAF	28	UAM	21
123	11	6	UAM	49	Mo	22
125	11	9	Si	25	UAF	16
91	10	7	Mo	66	UAM	16
76	10	9	Mo	30	Bro	17
33	9	13	Mo	56	UAM	10
255	9	8	Mo	63	UAF	15
227	8	8	Mo	56	UAF	12
284	8	13	Si	25	UAF	22
274	7	7	Mo	74	UAF	18
307	6	10	Mo	61	UAF	8
356	5	13	Mo	35	UAF	22
361	5	4	Mo	99	UAF	.5

Mo = mother; Dau = daughter; Son = son; Bro = brother; Si = sister; Cou = cousin; Gda = granddaughter; UAF = unrelated adult female; UAM = unrelated adult male;

strong tendency for their primary partner to be their mother. There was no case of an old animal with her mother, and no case of a young animal with a daughter. Since the generation length is 5 years, and the age categories span 10 years, it would be possible for a 20 year old to have a mother present, or a 10 year old to have an adult daughter present, however this was not the case with these data. It is clear that when available, daughters are the preferred partner, or the most frequent primary partner for old females. Seventy two percent of old females interacted first and foremost with a daughter. Likewise, mothers are the preferred partner for young females. Ninety percent of young females interacted first and foremost with their mother. For middle aged animals, 41.7 percent interacted primarily with their mother, and 16.7 percent with a daughter.

It is clear from a comparison of the old, middle, and young columns in Table 6.2 that there is much greater variability in middle aged animals in terms of the identity of their primary partner. When considering sons and daughters combined, as one identity class of 'offspring', they represent 83 percent of the primary partners for the aged group. In fact for the two females for whom a son was the primary partner, no adult daughter was available. One other class to be represented in the aged sample is granddaughter, and in this case, the subject female had neither sons, daughters, nor sisters in the troop. (A daughter was present until three years age, and at that time this mother and daughter pair were very close. In fact this female, #36, only recently developed a relationship with this granddaughter, who was orphaned many years earlier). Unrelated adult females complete the list of primary partners for aged females (N=2, 17%). In light of the very strong trend shown above for old females to interact primarily with an adult daughter, at least one of these cases is curious. Animal #40 interacted primarily with an unrelated adult female, #72, in spite of the fact that she

Table 6.2
IDENTITY OF PRIMARY PARTNER
SUMMARY STATISTICS

I.D. of Principle Partner	Total Sample N=40		Old N=18		Middle N=12		Young N=10	
	Raw Score (# of ind.)	%	Raw Score (# of ind.)	%	Raw Score (# of ind.)	%	Raw Score (# of ind.)	%
Mother	14	35	0	0	5	41.7	9	90
Daughter	15	37.5	13	72	2	16.7	0	0
Son	2	5	2	11	0	0	0	0
Brother	1	2.5	0	0	1	8.3	0	0
Sister	2	5	0	0	1	8.3	1	10
Granddaughter	1	2.5	1	5	0	0	0	0
Unrelated Adult Female	3	7.5	2	11	1	8.3	0	0
Unrelated Adult Male	2	5	0	0	2	16.7	0	0
Total	40	100	18	100	12	100	10	100

has both an adult daughter and an adult son in the troop. Subjectively, it appeared that this mother and daughter pair had a normal relationship, and the daughter does appear as the second partner to animal #40, although she accounts for only 20 percent of her mother's social contact time. The second case is an unusual animal who lived to be 22 years old, but never bore an offspring. She did, however, have two adult sisters in the troop, but she was never observed to interact with either of them. The sample of young females shows even less variability, with 90 percent of the subjects interacting primarily with their mother. The only other class to be represented is sister. The one animal, #284, whose first partner was her sister does have a mother present in the troop, as well as three adult sisters, all of whom interacted a great deal with their mother, and a great deal with each other.

The middle age animals showed the most variability in the identity of their strongest social partner. Of the 12 individuals, 5 interacted most with their mother, 2 with a daughter, 1 with a brother, 1 with a sister, 1 with a unrelated female, and 2 with unrelated adult males. The one who chose her brother was interesting because she had four adult daughters available. It thus seems that this was a clear choice, not the result of demographic circumstances. In both cases where sisters were the first partner, one in the young group and one in the middle group, the mother was present, but not necessarily available, since both of these mothers also had three other adult daughters in the troop. This sister partnership may therefore be a function of demographic realities. The one middle age female with an unrelated adult female as her primary partner had no close male or female kin in the troop. The two whose primary interactants were unrelated adult males are interesting cases. Both have close female kin available. One (#142) was noted, by the management and the researcher, to have a special relationship with this particular male (#61). Both the male and the female were members of the central body of the troop, yet were relatively peripheral and low ranking. The second female, #123, whose principle partner was a male, #1, is more curious because she had a mother and 2 adult sisters present.

The unrelated adult male in this case was the same adult male who appeared as the principle partner to his middle age sister (see above). This particular male, in fact, who shows up as the primary social partner for two of the subjects in this study, is widely held, by management and researchers, to be an almost lifetime mate of another female who was not a subject in this study. Possibly we are dealing with an unusually sociable male (he is also actively nurturant toward infants), and the presence of such a male may have important effects on the interaction patterns of some females.

It is clear from Table 6.2 that the age groups differ in terms of who is likely to be the primary social interactant. Old females are by far most likely to interact with an adult daughter, and then a son, if no daughter is available. Young females interact primarily with their mother, or as in the case of animal #284, with a sister, when competition for time with mother is steep. In the case of #284, the mother was not only in demand from three other adult daughters, but from many unrelated high ranking animals, as the mother of #284 is the alpha female.

The reader may also find it useful to compare the frequency of certain classes of animals, to each other, and across the rows of Table 6.2, and assess the importance or desirability of these classes as social partners. For example, it may be noted that brothers are rarely the first social partner of any adult female, and sisters are never, in this study, the primary partner of an old female, in spite of the fact that 10 of the aged subjects had adult sisters in the troop.

Table 6.3 summarizes the data on the identity of the second strongest relationship or partner of each of the subjects, as reflected in percentage of total social contact time spent with that individual. Age-related patterns are much less obvious in the identity of the secondary than in the first. This table shows greater overall variability. A new class of individuals appear, cousins, and the granddaughter class is absent. As discussed above, the one strong grandmother-granddaughter relationship was based upon unusual demographic circumstances.

Daughters as secondary partners comprise 33 percent of the aged group. Again, no young females have adult daughters. The fact that daughters continue to represent an important class of partners to middle and old females is probably a function of their availability, or their numbers. Mothers often have multiple adult daughters, and they would be expected to appear high on the list in the social network, although clearly, only one can be first.

Sisters appear now in the social network of the aged females, comprising 17 percent of the secondary partners for this age group. In the middle and young age groups, adult sisters are absent as secondary partners. Cousins occur only in the middle age group and comprise 17 percent of the secondary partners for this age group – possibly another indication of greater variability in choice of important social relationships in the middle years of life.

Unrelated adult males and females become very common in the total sample as secondary partners. They comprise 60 percent of the total sample, 50 percent of the aged group, 51 percent of the middle group, and 90 percent of the young group. While the actual strength of the relationship between individual subject females and unrelated adult males and females as secondary partners varies greatly (range from 0.5 to 23 percent, see Table 6.1), there is no doubt that their frequency of appearance in this position is very high, especially in the young animals. Since most of these animals have more than one close female kin member in the troop, it might be expected that kin members should continue to be important members of the social network beyond the primary partner. Yet these data show a sharp drop off in the incidence of kin from the first to the second partner.

Table 6.3
IDENTITY OF SECOND PARTNER
SUMMARY STATISTICS

I.D. of Principle Partner	Total Sample N=40		Old N=18		Middle N=12		Young N=10	
	Raw Score (# of ind.)	%	Raw Score (# of ind.)	%	Raw Score (# of ind.)	%	Raw Score (# of ind.)	%
Mother	1	2.5	0	0	1	8.3	0	0
Daughter	9	22.5	6	33	3	25	0	0
Son	0	0	0	0	0	0	0	0
Brother	1	2.5	0	0	0	0	1	10
Sister	3	7.5	3	17	0	0	0	0
Cousin	2	5	0	0	2	17.7	0	0
Unrelated Adult Female	16	40	7	39	2	17.7	7	70
Unrelated Adult Male	8	20	2	11	4	33.3	2	20
Total	40	100	18	100	12	100	10	100

Age differences in the incidence of non-kin in the secondary position are present. Unrelated adult females are most common in the young females (70 percent), moderately common in aged females (39 percent) and least common in middle age females (17.7 percent). Unrelated males, on the other hand, are most common in the middle age group (33 percent), then the young group (20 percent) and lastly the aged group (11 percent).

Within the sample of 40 females, 16 mother-daughter dyads were included. Since focal animal data were collected on both the mother and the daughter, each would receive an independent score for the strength of the relationship. Table 6.4 compares each of the mother-daughter dyads on the basis of the importance of the relationship to each animal, as reflected in the percentage of total social contact time that each individual devoted to the other.

The striking finding here is that mothers and daughters are not equally important to each other. In very few cases (2 out of 16) are the percentage scores very close, which would indicate a balanced relationship. In no case are they identical, and in the majority of cases (11 out of 16) the difference is greater than 20 percent. What is the direction of this difference? Are mothers more important to daughters, or daughters to mothers? In this sample of 16 dyads, the daughter is more important to the mother in 12 cases (75 percent).

A meaningful breakdown of this pattern is not readily evident. It is not possible to validly assess age differences in Table 6.4 because the mother are all aged, or very close to being aged. This does reflect a demographic reality – older females are more likely to have adult daughters – but in this case it is predominantly an effect of the selection of subjects. All animals 20 years of age and older were included as subjects, and their daughters were preferred as members of the comparative non-aged sample. Age variation (5 – 17 years) does exist within the daughters of these dyads, however it does not appear to explain the variation in relative importance. In the 4 cases (25 percent) where the mother scored higher in importance (as reflected in time spent) than the daughter, the daughters ages were 8, 8, 11, and 14.

Table 6.4
MOTHER AND DAUGHTER DYADS: COMPARISON OF THE RELATIVE IMPORTANCE OF EACH TO OTHER

DYADS		Percent of Daughter's Total Social Contact Time which is spent with Mother	Percent of Mother's Total Social Contact Time which is spent with Daughter
Mother	Daughter		
32	5	42	47
26	8	91	70
11	123	44	22
133	33	36	56
38	52	39	77
40	76	20	30
49	284	30	17
58	125	6	15
60	361	67	99
77	114	33	58
85	307	37	61
86	157	25	38
97	91	64	66
99	227	82	56
117	255	42	63
11	356	10	35

Dominance rank could possibly be a factor, since for three out of the four scores indicating that the mother was more important to the daughter than vise versa, the pairs were very high ranking. The fourth pair, are however, very low ranking. Furthermore, one of the very high ranking mothers (#11) appears in two dyads, since two of her daughters were included in the sample, and the pattern of importance is reversed between her two dyads.

To this point the social network data has been explored descriptively, focusing upon the first two members of the social network of each subject female. Subsequently four major variables were identified (age, rank, degree of kinship, and pattern of contact), and three measures of each (to a total of 12 network characteristic variables) were calculated for each female using the entire social network. Tables 6.5 to 6.7 present the results of the empirical testing of the null hypothesis that no significant differences occur in these characteristics of the social network as a function of the age of the subject.

Overall, in few of the 12 network variables identified and measured, was age a significant factor accounting for variation. In none of the statistical test performed, did age account for variation in the mean dominance rank, the variance in dominance rank, or the relative variation in dominance rank of the animals social network. In all of these dominance rank measures, variation did occur, however advancing age did not account for it.

Likewise the three kinship measures were not affected by the age of the animal. Apparently the importance of kin group members in an animal's social network is relatively constant over the life course. In Table 6.6, the degree of kinship in the social network scores are very close, although lower in the middle years than in either early or late. This may be related to the trend which appeared earlier in terms of greater variation in the content of the social network of middle age animals. Since the equality of variances among the three age groups did not hold true for this set of scores, statistical testing of the difference in these means was not possible. The Kruskal-Wallis analysis of variance of ranked scores, while showing the same tendency, was not significant.

The three "pattern of contact" scores were an attempt to quantify the variation which occurred, among females, in terms of the size of their social networks and the distribution of time spent among the members of that network. It was clear from the field observations that some animals had one or even two very strong partners, with whom they seemed to spend most of their time, while other animals distributed their time much more evenly over a number of partners. This analysis was unable to uncover any pattern which could be related to the age of the subject animal, either in the average amount of time devoted to any other animal, or in the two variation scores. Whether the tendency to have a few strong versus many casual relationships is idiosyncratic, a function of personality, or related to other socio-demographic characteristics of the subject is not clear. From this analysis it appears to be unrelated to age.

Interestingly, the one group of social network characteristic variables which do relate to the age of the subject are the age variables. The generalized age score for the network – the mean age of the individuals in the network weighted by the percent of social contact time spent with the individual – shows a weak negative correlation with age ($r = -0.27$). In Table 6.6 we can see that the mean age of the individuals in the social network of old animals is 13.6, of middle age animals is 14.5, and of young animals is 16.4. While the age change is not of a large magnitude, there is a tendency for older animals to interact with a younger group of others, and the younger animals to interact with an older group of others. This result is supported by the tendency noted above (see Table 6.2) for old females to interact with a daughter, and for young females to interact with their mother.

The negative correlation between the age of the subject and the variance in the age scores of animals in the social network is stronger ($r=-0.43$, $p=0.01$). This result is supported by all statistical tests performed on both the variance and the coefficient of relative variation. Table 6.6 shows the variance scores for each of the three age groups and the results of the analysis of variance. From this table it is clear that there is an increase in variance as we move from old to young subjects. It is also clear that the strongest difference is between the middle and the young groups. Young females interact with a much broader range of other age groups than do either middle age or old females, with old females interacting with the narrowest range of other age groups. It was pointed out above that in the identity of the first two partners in the network, the middle age animals showed more variation. Here, however, we see that in terms of variation in age, when the entire network is considered, the young show the most variation. Old females, then, show a reduction in the range of other age groups with whom they interact.

Table 6.5
RESULTS OF PEARSON CORRELATIONS
AGE AND CHARACTERISTICS OF THE SOCIAL NETWORK

Network Characteristics	r value	p value
Rank	-0.06	0.73
Variance in Rank	0.02	0.92
Relative Variation in Rank	0.14	0.38
Age	-0.27	0.09*
Variance in Age	-0.43	0.01*
Relative Variation in Age	-0.37	0.02*
Degree of Kinship	0.11	0.48
Variance in Degree of Kinship	-0.09	0.59
Relative Variation in Degree of Kinship	-0.26	0.11
Average Amount of Time the Subject spends with any other	0.08	0.60
Variance in Amount of Time Subject spends with others	-0.13	0.42
Relative Variation in Amount of Time Subject spends with others	-0.15	0.35

Table 6.6
ANALYSIS OF VARIANCE
3 AGE CATEGORIES BY
CHARACTERISTICS OF THE SOCIAL NETWORK

Network Characteristics	Grand Mean N=40	Old N=18	Middle N=12	Young N=10	F value	p value
Rank	13.8	14.4	13.4	13.0	0.27	0.77
Variance in Rank	22.1	21.2	19.9	26.2	0.39	0.68
Relative Variation in Rank	2.3	2.1	2.5	2.4	NA	NA
Age	14.6	13.6	14.5	16.4	2.23	0.12
Variance in Age	39.9	30.6	38.6	58.2	NA	NA
Relative Variation in Age	2.7	2.2	2.8	3.6	4.0	0.02
Degree of Kinship	0.29	0.30	0.26	0.30	0.64	0.52
Variance in Degree of Kinship	0.08	0.08	0.07	0.09	1.4	0.23
Relative Variation in Degree of Kinship	0.28	0.25	0.31	0.32	1.9	0.15
Average Amount of Time the Subject spends with any other	23.1	25.3	21.0	21.7	0.60	0.55
Variance in Amount of Time Subject spends with others	113120	75367	81784	87694	0.22	0.80
Relative Variation in Amount of Time Subject spends with others	47.8	42.1	46.5	59.7	0.55	0.58

Table 6.7
KRUSKAL-WALLIS
3 AGE CATEGORIES BY
CHARACTERISTICS OF THE SOCIAL NETWORK

Network Characteristics	Average Rank Score Old N=18	 Middle N=12	 Young N=10	Statistic	p value
Rank	22	19	19	0.65	0.72
Variance in Rank	21	17	24	1.81	0.41
Relative Variation in Rank	20	18	24	1.56	0.46
Age	18	20	2	4.37	0.11
Variance in Age	16	20	29	7.42	0.02
Relative Variation in Age	17	21	27	4.74	0.09
Degree of Kinship	22	19	21	0.64	0.72
Variance in Degree of Kinship	19	18	26	2.97	0.22
Relative Variation in Degree of Kinship	16	23	25	4.36	0.11
Average Amount of Time the Subject spends with any other	23	19	17	2.08	0.35
Variance in Amount of Time Subject spends with others	22	19	21	0.53	0.77
Relative Variation in Amount of Time Subject spends with others	20	19	24	1.08	0.58

DISCUSSION

Chapter 4 of this thesis addressed, tested, and discussed the commonly held notion that old monkeys will experience a disengagement from their social world, a tendency toward social isolation. The sociability of animals was measured in two ways: the total amount of time which the animals were observed to spend in social contact, and the total number of other animals with whom they were observed to spend time. This second measure, the total number of others with whom the subject spent time, is basically a measure of the animal's social network size. No age-related variation was found in the size of the social network of animals of different age groups, although the expectation that old females will have smaller networks is prevalent.

The absence of a change in the size of the social network of animals of advanced age does not complete the investigation of possible changes in social network. Social networks may vary not only in size, but also in content. If a change in the relationship of the individual to the social group is occurring, as individuals age, the change may manifest itself in more subtle ways, for example in the 'quality' or content of the social network. The purpose of this chapter is to investigate the social networks of a sample of 40 adult female Japanese monkeys in order to assess the possibility that qualitative changes occur in the social networks of animals in the latter portion of the lifespan.

Many of the theoretical approaches in social gerontology are essentially concerned with changes in the social life or in the social position of the elderly. Concern with loneliness and isolation among the aged is fundamental. Disengagement theory (Cumming and Henry, 1961) specifically refers to changes (reductions) in the quantity and quality of social interactions. Activity theory is equally concerned with the social network of the aged, suggesting however that social involvement and activity should be high (Havigurst and Albrecht, 1953). Continuity theory is another variation on the same theme. According to Continuity theory, the important element is continuity, the maintenance of earlier life patterns of activity and interaction (Williams and Wirths, 1965; Atchley, 1971). The social network concept is fundamental to social gerontology, whether implicitly or explicitly.

There is a considerable body of data dealing directly and indirectly with changes in the social networks of individuals as they get old. Isolation is probably the main theme, however, quality and content changes are also discussed. Much of this body of research is not applicable to nonhuman primates because of the emphasis on subjective involvement in networks, normative characteristics of the networks, variation in the psychological needs of the individuals and distinctions such as isolation versus loneliness (Blau, 1973) and loneliness and aloneness (Shanas, 1970). Also, two types of networks are distinguished: dyadic and multiple. Multiple networks are ones in which a connection or relationship between the members is implied, as in, for example, a religious group as a network. In the present study, the individual is used as the point of departure, and the sum of the dyadic connections is considered to be the network for the individual. Very little information is available on the extent to which the members of an individual's social network have relationships with one another, except possibly in the cases discussed of a mother with multiple daughters. Dyadic network involvement is therefore the focus of the current study, and therefore appropriate comparative human literature will focus upon dyadic relationships. Unfortunately, the life course perspective on dyads comes mainly from marital studies, such as changes in the husband-wife relationship, and most commonly, role changes at retirement (Lowenthal and Robinson, 1976).

In spite of the fact that much of the literature on social networks in social gerontology is inappropriate for a nonhuman comparison, some hypotheses and some loosely formulated notions of this kind do exist. Age homophyly (Hess, 1972) is commonly mentioned. This is the hypothesis that individuals will interact primarily with age mates. This pattern is undoubtedly associated with situations in the industrialized world of institutionalization and retirement villages. Alternatively, it has been suggested that family becomes more important to an individual in their later years. Many medical and psychological factors may be involved in this (for example, relatives are turned to first in a health crisis; see Hochshild, 1973), although demographic realities probably prevail. In the absence of age homogeneous living situations, one might well expect the elderly to find themselves in a shrinking age class, as cohort members die off.

Shanas (1968) found that regarding helping behavior, the elderly turned first to their children. Daughters were preferred, but sons came next if daughters were not available. When children were unavailable, siblings became the source of support. Although seeking support in infirmity was not the foundation , the data on Japanese monkeys in this study showed a very similar pattern of interaction, particularly with respect to sons and daughters. The importance of siblings to aged monkeys is not particularly clear.

The composition of the age structure would certainly be expected to have an impact on the social networks of individuals, simply by determining available partners. However the exact nature of this effect will depend in large part on the social structure within which it occurs. In many human societies, family is most important in earlier life, however as the individual matures socially, peers and age-mates replace family members in the social network. There is a strong tendency for most social interaction outside the family to occur within age and class strata (McPherson, 1983). What age-related changes might be expected in a Japanese macaque society?

The results of the data analysis in this study indicate that young females interact primarily with their mothers, and old females primarily with their daughters. Kinship affiliations are clearly very important across the lifespan. In some human cultures, specifically Western ones, social norms stress independence between adult children and parents and this can lead to older persons being normatively isolated from kinship networks (Lowenthal and Robinson, 1976). Clearly this kind of effect is absent in Japanese macaque society, and the pattern of contact with close kin is primarily affected by the availability of close kin at all stages of the life course. Unless a female in completely infertile, the likelihood of having living descendents is very high. This mother-offspring bond, often quoted as the primary unit in primate society, overrides any effect of cohort shrinkage in old age. Age mates are apparently not the preferred partners – in fact the statistical tests indicate a negative correlation between the age of an individual and the age of its interactants: reverse homophyly.

These data showed no evidence of kin becoming more or less important as a function of age. It was noted that the close kin members are highly common as primary partners in the social network, but drop off considerably after that. However, this was not an age-related pattern.

Kinship and age, then, as important variables in terms of the content of one's social network, operate quite differently in human and nonhuman societies. For monkeys, the importance of kin is high and constant throughout the life span, primarily as manifest in the mother-offspring, specifically the mother-daughter, relationship. The mother-daughter age difference leads to a reverse of age-homophyly.

Variance in the age of interactants was shown to be high in young females and low in old females. If the mother-daughter relationship is primary, then this may be understood in demographic terms. Generally speaking, within the adult population a set of offspring (siblings) will tend to be closer in age to each other than to their mother. With multiple offspring an older mother may share her time among similarly aged offspring. A young animal is likely to share time first with its older mother, and then with age similar siblings, creating the increase in variance.

In human society, the theme of reduced status of the elderly (socio-economic or other) is paramount. The aged class as a whole, or at least large segments of it are expected to drop in status. Because of this they may also be expected to interact more with others of low status. The nonhuman equivalent would be social dominance. In none of the statistical tests performed, did age account for variation in the dominance scores of the animal's social network. However, in Japanese macaque society in general, there is no evidence, contrary to the popular expectation based on human bias, that as females age, they rise or fall in rank. Dominance rank is largely a function of lineage membership and lifetime affiliations. Animals generally live out their lives in the rank to which they were born. Kinship affiliations, specifically the mother-daughter relationship, will be as rank homogeneous as it is age heterogeneous. Aged animals therefore would not change rank levels in terms of interactants.

Overall, changes in the content of the social network of elderly monkeys are far fewer than those reported for humans. The identity of the primary partners tends to change from mother, in youth, to a daughter, in old age, and, as a function of this, there is a negative correlation between the age of the individual, and the mean age of the individuals in their social network. This change is due to the realities of demography within the all important mother-daughter bond. It is in fact a time-dependent change, not one that is based in changing characteristics of the aging individual. Based on human circumstances, one could imagine a scenario where old females are shunned by younger family members due to decreased energy or mobility, and consequently, interacted with other aged females in a similar situation. But this does not occur. No evidence was found that aged individuals withdraw or alter the composition of their social networks as a direct result of an aging phenomenon.

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CHAPTER SEVEN
CONCLUSION

Interest in the social behavior of aging monkeys is relatively recent, undoubtedly stimulated by the multi-disciplinary surge of interest in human aging. Cross-species comparison is as much a contribution to the study of aging, in general, and human aging specifically, as cross-cultural comparison is a contribution to the study of human aging, in general, and aging in Western industrialized society, specifically. Investigation of aging in preliterate society aids in the identification of panhuman aging patterns, as well as highlighting, for the Western social gerontologist, the uniqueness of aging in modern society, and the conditions which cause it to be so. Likewise, knowledge of aging in monkey society puts human aging in perspective, clarifying primate-wide patterns and/or the uniqueness of human aging.

The uniqueness of human aging is the most salient comparative result of this investigation into aging in a nonhuman primate society. The small body of previous research into old monkey behavior has tended to present a picture of similarity between old humans and old monkeys. That the early research has expected, presented, and accepted such similarity without controversy is in itself curious. Commonly, in areas of potential human comparison, nonhuman primates are approached with an a priori assumption of absolute human uniqueness, and subsequent reports of similarity and overlap result in heated controversy. Evidence that the great apes may be able to use language, make and use tools, and tolerate scrounging (rudimentary food sharing?) are examples of this. The early investigation of aging in nonhuman (specifically monkey) society has been remarkably uncontroversial, especially given the apparent similarity to humans. Of course the way we grow old has never been held up as one of the hallmarks of human society. Also, the research is very limited and, the only trends to have emerged are the expectation and acceptance that old monkeys will represent a distinguishable social category, with age specific behavior patterns, and specifically, that they will experience social withdrawal.

This last point alone should have aroused some suspicion. Isolation and social withdrawal have been the identifying and unifying themes of social gerontology, if not the predominant element in the popular perception of the aged. However, the activity versus disengagement debate raged for 20 years in social gerontology, and has never been resolved. Some decrease in the life space may occur in modern industrial societies (the perception had to come from somewhere), but, we do not know what proportion of the aged are involved, we have no evidence that this pattern is associated with "successful aging" (ie. that it should occur), and we have good reason to believe that it is a creation of modernization. Disengagement has not been documented cross-culturally. So, with quantification and documentation of the popularly perceived pattern of social withdrawal so difficult to come by in human society, it is curious that this very specifically human theme should emerge so clearly in the very early literature on old monkeys. Primatologists have been watching and studying monkeys in the field and in captivity for decades, and many interesting social and behavioral patterns have been described. Infant behavior is described and discussed, juvenile behavior is described and discussed, males are contrasted with females, mothers are compared to non-mothers, new mothers are compared to experienced mothers, sexual behavior is contrasted with non-sexual social behavior, dominance relationships are described and discussed, kin versus non-kin patterns of behavior and interaction are described and discussed. But in all the years that primatologists were watching monkeys and addressing themselves to a myriad of visible social patterns, the old animals never emerged as a distinct group, never became the object of direct study. In short, they were never identified as a group with any distinct or specific behavior patterns, even in many studies seeking to document sources of variation in adult female behavior. Not until social gerontology became a full scale widespread academic concern did old monkeys become the object of direct study. In fact, I would suggest that old monkeys as a social category, are a creation of 'gerontological primatologists'. When describing my intention to study old monkeys to primatologists unfamiliar with the small body of research on old monkeys and unfamiliar with the trends and themes of social gerontology, I met with considerable and persistent skepticism. "Why *old* monkeys? What about *old* monkeys? What is different or interesting about *old* monkeys?" What is interesting about old monkeys is that attention is now turning to them because of the high profile of social gerontology. More importantly, to someone familiar with the trends and themes of social gerontology, the emerging primatological picture is a suspiciously simple and familiar one.

Most primatologists are anthropologists, not zoologists. This means that the ultimate goal of our research is to contribute to the understanding of human evolution and human social life, by providing cross-species comparisons which put the human case within the broader primate perspective. While certainly not every research project can be directly applied or linked to humans, every research project contributes a small piece to the primate puzzle, of which humans are a part. Some research areas, however, do have direct applicability in terms of human comparison, and in these areas primatologists have an obligation to provide an accurate picture of the nonhuman case, one which is conceptually and methodologically sound. The gerontological comparison is particularly sensitive because social gerontology is concerned with both social science issues, and concrete, current, social problems. While I certainly would not argue that policy planners are, at this time, taking the cross-species information into account, the fact is that they could, and even if they never do, social gerontologists with more academic interests probably will. The knowledge that a behavioral trend, such as social withdrawal in old age, is primate-wide, would be very relevant to theory formation (and possibly subsequent social policy). Although it would run counter to the cross-cultural trend, the belief that aged withdrawal is a primate pattern would probably lead to its treatment as a pattern which is part of our primate heritage and therefore biologically based. Or if not biologically based, it is at least a fundamental, possibly unalterable, product of social life in higher order mammals.

The research which has been done on the social behavior of old monkeys has, for the most part, not been methodologically sound. This is certainly not because of negligence on the part of researchers. The subject matter itself is largely inaccessible. In wild animals, age must be estimated on the basis on appearance, and perhaps even behavior. The potential for human bias in judgement in this area of research is obviously great, and in many ways unavoidable. Animals will not be identified as old because they look and act *unlike* what we expect of the old. Social groups of animals of known age are rare, and individuals known to be old rarer still. After all, the life span of most monkeys is about as long as primatology has been a discipline, and about three times longer than the time since any primatologists became interested in gerontology. Japanese monkeys, thanks to the early awareness by Japanese scientists of the importance of longitudinal research, are the saving grace. However, even for Japanese monkeys, the gerontological research has involved small numbers of animals and very short-term cross-sectional sampling.

The present study was undertaken because of: a) the high level of interest in old age in both the professional and public arenas; b) a knowledge of the methodological shortcomings of earlier research, much of which could be rectified; and c) some doubt about the emerging picture of old monkeys as being very much like the popular conception of old people. When the results failed to demonstrate age-related changes in sociability, in individual behavior patterns, or in more subtle and intricate characteristics of the content and patterning of social networks, it became apparent that some rethinking of the question was in order. Why were old monkeys expected to be, like old humans, a socially recognizable sub-group of individuals? What is different about aging in a monkey society from aging in a human society that might explain these results? What characteristics of human society, which relate to the later portion of the lifespan, distinguish it from monkey society? The following three elements (discussed briefly in Chapter 2) were identified.

Menopause

The lengthy postreproductive lifespan of the human female is unique among the primates. Researchers claim to have found evidence of reproductive senescence in rhesus monkeys (Hodgen, et al. 1977). However, in assessing what is offered as evidence of menopause, the distinction must be made between an unusual individual phenomenon, and one which characterizes a population. Certainly, cases of old female monkeys who have ceased to reproduce can be found, but the fact remains that the *lengthy* post reproductive lifespan of all human females who live a normal lifespan is unlike anything that has yet been reported in the nonhuman primate world. Graham (1979) found no evidence of menopause in chimpanzees. Graham et al. (1979) performed in depth investigations of hormonal and histological evidence for menopause in pigtailed macaques as well as reviewing the literature on this subject. These authors conclude that "there are no data to indicate that the endocrinological changes characteristic of peri-menopausal women are paralleled in nonhuman primates"(1979:199). Small (1984), citing Hodgen et al. (1977), comments that menopause occurs in macaques in the third decade, however "few females reach this age"(1984:256). In other words, most females continue to reproduce until death. In Japanese monkeys, Fedigan (1987) found that the mean age at death for the old females is 23, and the mean age at last birth is 22.

Whether menopause in the human female has been the object of direct evolutionary forces, or whether the extended lifespan post-reproductively is the result of cultural advance, the fact remains that this situation is unique. A biological model of the human female life course would show a reproductive/post-reproductive demarcation which is quite distinct from the gradual senescence which occurs in the other biological systems (i.e. visual, auditory, cognitive). In non-human primates it is not possible to clearly distinguish reproductive senescence from the general biological decline of the organism.

The reality of menopause, a postreproductive lifespan, and the ramifications thereof certainly render the human life course unique. In social gerontology, the impact of non-reproduction on the social experience of aging humans is not explicitly addressed, since it is a universal feature of human life and society, and is therefore generally taken for granted. Admittedly, the social and cultural manifestations of the change of life for women varies widely from culture to culture.

Awareness of Mortality

Another fact of human life which has profound implications for approaching the end of the lifespan is the *knowledge that one is approaching the end of the lifespan.* Without an awareness of death or mortality, monkeys could certainly not be expected to experience aging in the same or even a very similar way, to that of humans. It is true that monkeys recognize a dead animal as no longer a member of the social group. It is also true that in apes, severe grief is often associated with the death of a close friend or relative. However, this is quite different from having a sense of one's own mortality, a sense of self, a sense that life is more than oneself. An awareness of death or mortality requires, at the very least, that the individual be an object unto itself. We have no reason to believe that monkeys have the ability to interpret and give meaning to the biological changes which may be occurring. Humans are believed to have had the first stirrings of such notions only forty to eighty thousand years ago. The awareness of mortality is another distinction between humans and monkeys which has a direct and profound effect on the social and psychological experience of aging.

Division of Labor

A division of labor is commonly considered to be one of the primary diagnostic features of human social life. Leibowitz (1983) points out that underlying any division of labor are production and exchange. Production involves the acquisition of greater amounts of goods than the individual is able to make use of. Exchange occurs when individuals share these goods with one another. Interindividual dependence is one major ramification of this division of labor. Individuals are not complete and independent subsistence units, but rather rely on production and exchange for survival. "Only humans *depend* on the sharing of food resources ... and the measurement of such 'dependence' for cross-species comparison would be difficult (Nash, 1981).

Humans therefore depend upon one another in a direct and fundamental way. The fact of interindividual dependence is exemplified in the case of individuals who are unable to care for themselves, or to reciprocate in the exchange of goods and services. In human society, non-productive members such as children, and the ill or infirm, are 'carried' by the society.

The concept and reality of *dependence* is central to social gerontology. Because of the tendency for the elderly to have a higher likelihood of infirmity and because of social norms regarding continued labor in the years when the end of the lifespan is approaching, the elderly are often economically dependent – no longer actively involved in production.

Social exchange theory has been applied to the elderly. Dowd (1975) offers an explanation for social withdrawal by the aged based on the fundamentals of reciprocity and exchange. The elderly experience various losses, in, for example, health, finances, and mobility, and therefore have fewer resources at their disposal. They are subsequently unable to engage in balanced reciprocal exchange, and instead, become 'takes' more than 'givers'. This is what renders the individual dependent, because they must rely on others to engage in unreciprocated exchange. Because this situation is undesirable for both parties, possibly more so for the elderly, they withdraw, wherever possible from social exchange encounters.

Few would argue with the assertion that nonhuman primates, especially monkeys, do not possess a division of labor involving production and exchange. Some authors have tried to argue for the existence of a rudimentary or protosexual division of labor in some pongid groups on the bases of ecological separation of males and females (e.g. Galdikas and Teleki, 1981). However, the actual degree of ecological separation between pongid males and females is not at all clear, since the all-important meat eating by male chimps is rare (Leibowitz, 1983), is not exclusively male (Nishida, 1981), and since there are no reports of any ecological separation in either gorillas or pygmy chimps (Fleagle, 1981). More importantly, there is little in the way of a logical connection between pongid male and female dietary differences and the labor division of hominids (Kelso, 1981).

I am unaware of any arguments promoting the existence of a division of labor in monkeys, in spite of the ecological variation which may accompany the 'wandering tendencies' of males in many monkey species. Monkeys do not share food (beyond nursing infants), even in a rudimentary way such as 'tolerated scrounging'. Side by side foraging implies no sharing related to production and exchange. Each individual animal, once weaned, is a complete subsistence unit, not directly dependent for survival on any other individual. The carrying of nonproductive members by human society appears in the archeological record very recently. Regardless of the tendency toward ecological separation or rudimentary sharing behavior, nothing like the care and feeding of incapacitated adult animals has been reported for any nonhuman primate species.

The division of labor and subsequent interindividual dependence in humans is absent in nonhumans. This distinction has major ramifications for the comparison of aging in human and nonhuman primate groups. Dependence is central to aging in humans, and contributes to the different social and behavioral conditions of the elderly and non-elderly adults. (It is important to note that the aged are not a homogeneous group, and all elderly are not dependent physically, socially, or economically, any more than all non-aged adults are independent, and able to engage in reciprocal exchange.)

Clearly, the subject matter of social gerontology would be radically different if women could continue to give birth into their sixties and seventies, if everyone were independent, and if there were no knowledge that one's life would soon, or even eventually, end. Conversely, for monkeys, why would we expect there to be a social stage or category for the elderly (as one could argue there is for juveniles), with females having babies right up to an end that they do not even know is coming. Would not adulthood in this case be much more continuous to death? Of course biological aging does occur, but how extensive would the social manifestations of this biological process be? My point is that aging in humans is unique for at least these three reasons, and it is unwise to seek to understand old monkeys without explicitly acknowledging these distinctions and the very different social realities that may result because of them.

I submit that a model of the human life course, biological or social, will show distinctions which demarcate the aged as a distinct group, however blurred the actual boundary between the aged and non-aged may be. Non-human primates, on the other hand, will show a life course with no clear demarcation past the attainment of adulthood, which is essentially continuous until death. The important organizing principles of monkey society are not age-related ones, and nothing occurs in the later portion of the life course to change this. The gradual biological changes which occur over time in all living organisms are not sufficient to set in motion changes in social organization or social relationships. The only biological change with real significance is death, in which case the individual is suddenly removed, and the society quickly adjusts and continues.

The mother-offspring bond has long been heralded as the basic unit of primate society, and its importance in youth and endurance into adulthood has received much attention. It is clear from this study that the importance of this primary bond extends to the end of the lifespan, and the continuity in this fundamental unit of society is probably responsible for the essential continuity in the life course of female monkeys, from the attainment of adulthood through to death. Herein may lie an important thread of continuity between cross-species gerontology, cross-cultural gerontology, and social gerontology in the West. In all cases the relationship between mother and offspring, particularly mother and daughter (or daughter-in-law), is paramount in determining the situation of old women. In modern and preliterate societies the situation of old women, because of the intimacy and affection involved in the mother's social bonds, is contrasted with the situation of old men. The realities and repercussions of child bearing and rearing seem to be a point of commonality for all female primates, one which produces similarity across the lifespan.

I have argued that in Japanese monkeys, and probably nonhuman primates in general, the aged females are not distinct from other adult females in any important and discernible way. However, this is not meant to close the book on investigations of old nonhuman primates. A number of exciting future research directions are open. First, the results of this study need to be confirmed on other species of monkeys, particularly ones with a different social organization. Second, old males need attention. Interesting and comparable circumstances exist for male primates in general, and documentation of the aging of male monkeys may provide interesting comparisons with old female monkeys, with old male humans, and ultimately between male primates and female primates. Third, aging needs to be extensively studied in the great apes, where some slight blurring of the important distinctions identified here may occur, as researchers continue to look for evidence of self awareness, a division of labor, and menopause. Finally, when all of this is done, we may be in a position to speculate on the evolution of the hominid life course.

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